SECRETS OF SATURN'S RINGS REVEALED – PAGE 49

Astronomy®

AMERICA'S BEST-SELLING ASTRONOMY MAGAZINE

December 2002

Do you believe in the BIG BANG? 5 reasons you should

How NASA will deflect doomsday asteroids

View ECLIPSES of Jupiter's moons

Testing the RC Optical Systems 12.5

Explore rich star clusters in Auriga

astronomy.com

$4.95 • $6.95 Canada

12>

0 74820 08070 2

The Meade 30th anniversary sale

Buy a Meade LX90 or LX200GPS Schmidt-Cassegrain at the lowest prices ever offered!

Founded in 1972 as a one-person kitchen table mail-order operation, Meade Instruments has grown to become a $100 million enterprise with 500 employees and with distributors in 36 countries. This record of growth has been made possible by the astronomical community — amateur and professional astronomers and educators — who have made Meade the largest-selling telescopes in the world. Now, in celebration of our 30th year, Meade LX90 and LX200GPS telescopes are available for a limited time at their lowest prices ever.

8" LX90	*reg.* **$1695;** *now*	**$1495;** *save*	**$200**
8" LX200GPS	*reg.* **$2495;** *now*	**$1995;** *save*	**$500**
10" LX200GPS	*reg.* **$2995;** *now*	**$2495;** *save*	**$500**
12" LX200GPS	*reg.* **$3495;** *now*	**$2995;** *save*	**$500**
7" LX200GPS	*reg.* **$2995;** *now*	**$2495;** *save*	**$500**

Ultra-High Transmission Coatings (UHTC) group: *(see facing page)* 8" LX90 or 8" LX200GPS – $175; 10" LX200GPS – $235; 12" LX200GPS – $295; 14" LX200GPS – $350; 7" LX200GPS Maksutov-Cassegrain – $150.

Packing & shipping charges in the 48 states: 8" LX90 – $95; 8" LX200GPS – $105; 10" – $145; 12" – $215; 14" – $265; 7" – $125. Prices shown are suggested U.S. national mail-order retail prices. Certain Meade telescopes and Autostar control systems are manufactured under U.S. Patent Nos. 6,304,376 and 6,392,799; other patents pending in the U.S.A. and worldwide. Special LX90 and LX200GPS prices are valid for purchases from authorized Meade dealers in the U.S.A. **between September 15 - November 30, 2002.**

MEADE
LX200GPS
New!
14" LX200GPS
$4295
MEADE
LX200GPS
12" LX200GPS
reg. $3495
now $2995
MEADE
LX200GPS
10" LX200GPS
reg. $2995
now $2495

AUTHORIZED MAIL-ORDER DEALERS

ASTRONOMICS, Norman, OK.
Orders: 800-422-7876; Info.: 405-364-0858.

ANACORTES TELESCOPE, Anacortes, WA.
Orders & Information: 800-850-2001.

FOCUS CAMERA, Brooklyn, NY.
Orders: 800-221-0828; Info.: 718-436-6262.

OCEANSIDE PHOTO & TELESCOPE, Oceanside, CA.
Orders & Information: 800-483-6287.

SHUTAN CAMERA & VIDEO, Chicago, IL.
Orders & Info.: 800-621-2248; IL: 847-367-4600.

WOODLAND HILLS CAMERA & TELESCOPE, Woodland Hills, CA.
Orders: 888-427-8766; Info.: 818-347-2270.

RIVERS CAMERA, Dover, NH.
Orders: 800-245-7963; Info.: 603-742-4888.

EFSTONSCIENCE, Toronto, Ontario, Canada
Orders & Information: 416-787-4581.

KHAN SCOPE CENTRE, Toronto, Ontario, Canada
Orders & Information: 416-783-4140.

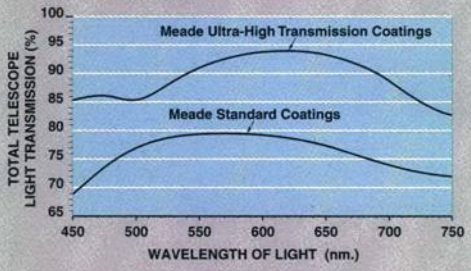
DPM Library

Buy a $650 Super Plössl eyepiece set for your LX90 or LX200GPS for only $99!

Through November 30, 2002, you can buy a full set of Meade premium-grade Series 4000 Super Plössl eyepieces, packed in a Meade #771 aluminum carrying case, for only **$99** with the purchase of a Meade LX90 or LX200GPS telescope.

See the full-page Meade ad in this issue for complete terms and conditions on this amazing offer.

Meade Ultra-High Transmission Coatings (UHTC) Group: The optical coatings provided as standard equipment with Meade Schmidt-Cassegrains equal or exceed the reflectivity/transmission of virtually any coatings currently offered in the commercial telescope industry. Alternatively, however, the UHTC group is available optionally at the time of telescope purchase on Meade LX90 and LX200GPS models and includes an exotic series of multi-layer coatings on the telescope mirrors and on the correcting lens. The UHTC group dramatically increases image brightness by about 20% across the visible spectrum. *Image brightness of the Meade 10" LX200GPS, for example, is effectively increased by about one full inch of aperture.*



SPECIFICATIONS: 8" LX90 — Each complete telescope includes 8" f/10 Schmidt-Cassegrain optical tube assembly with MgF_2 coatings on the correcting lens and standard aluminum coatings on the primary and secondary mirrors (Ultra-High Transmission Coatings available optionally); double-tine fork mount with dual-axis 4.9" worm gears and control panel; electric slow-motion controls on both axes; Autostar hand controller with digital readout display, 9-speed drive controls on both axes, and GO TO controller; 30,223-object onboard celestial software library; internal battery port accepts 8 (user-supplied) C-cells (optional 25 ft. cords permit powering from either 12vDC auto cigarette lighter plug or from 115vAC home outlet); 8 x 50mm viewfinder; 1.25" diagonal prism; Series 4000 Super Plössl 26mm eyepiece; standard field tripod; operating instructions.

SPECIFICATIONS: 7", 8", 10", 12", and 14" LX200GPS — Each complete telescope includes 8", 10", 12" or 14" f/10 Schmidt-Cassegrain or 7" f/15 Maksutov-Cassegrain optical tube assembly with MgF_2 coatings on the correcting lens and standard aluminum coatings on the primary and secondary mirrors (Ultra-High Transmission Coatings available optionally); primary mirror lock; 4-speed zero image-shift microfocuser; heavy-duty fork mount with 4" polar ball bearing, dual-axis 5.75" worm gears, and 7-port multi-function control panel, including two RS-232 serial interface ports; manual and electric slow-motion controls on both axes; Autostar II control system with 3.5-Megabyte flash memory, digital readout display, permanently programmable Smart Drive and 185-speed drive controls on both axes, High-Precision Pointing, and GO TO controller; 145,000-object onboard celestial software library; GPS alignment system with 16-channel GPS receiver, magnetic declination compensation, and true-level and North electronic sensors; 12vDC telescope power supplied from internal battery compartments accepting 8 (user-supplied) C-cells (optional 25 ft. cords available for powering from auto cigarette lighter plug or from 115vAC); 8 x 50mm viewfinder; 1.25" diagonal prism (7", 8", 10") or 2" diagonal mirror with 1.25" adapter (12", 14"); Series 4000 Super Plössl 26mm eyepiece; standard field tripod (7", 8", 10") or giant field tripod (12", 14"); operating instructions.

MEADE
LX200GPS
MEADE
LX200GPS
MEADE
LX90
8" LX200GPS
reg. $2495
now $1995
7" LX200GPS
reg. $2995
now $2495
8" LX90
reg. $1695
now $1495

New 2002 Meade General Catalog!

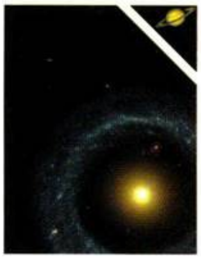
Call, write or fax for your free copy.

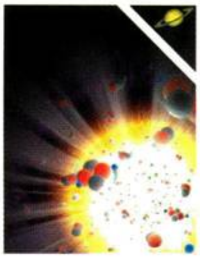
ADVANCED PRODUCTS DIVISION

Meade Instruments Corporation

The largest-selling telescopes in the world. ■ *A NASDAQ® company.*
6001 Oak Canyon, Irvine, California 92618 ■ (949) 451-1450
1-800-62-MEADE ■ FAX: (949) 451-1460 ■ *www.meade.com*

© 2002





December 2002 • Vol. 30, No. 12

Astronomy®

COVER IMAGES: Hoag's Object: NASA and the Hubble Heritage Team / Big Bang (selected covers only): Terri Field / Saturn: NASA

FEATURES

COVER

34 Do You Believe in The Big Bang?

Just one in three Americans believes the universe was created in a cosmic explosion. Here are five reasons why everyone should. *Jim Sweitzer*

42 Dodging an Asteroid

Astronomers have 900 years to avoid the possibility, albeit small, of a kilometer-wide asteroid impact with Earth. *David L. Chandler*

49 Exposing Saturn's Secrets

The mysteries of Saturn's rings exasperated Galileo. This information would've lowered his blood pressure. *Alan Rubin*

68 Shadow Play around Jupiter

Take eclipse watching to a new level. For the next year, Jupiter's four big moons will repeatedly obscure one another. *Richard Talcott*

74 Celestial Portraits: Auriga

Glittering clusters and vast gas clouds populate the Milky Way in the constellation of the Charioteer. *Tom Polakis*

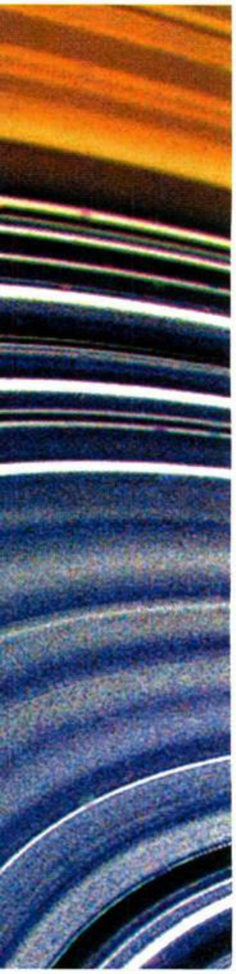
80 An Eye for Luxury

The 12.5-inch Ritchey-Chrétien scope from RC Optical Systems proves an ideal choice for backyard astroimagers. *Gregory Terrance*

84 William Lassell – 19th Century Astronomer

Beer brewer William Lassell was the British "Grand Amateur" of the 19th century — an innovative instrument designer, telescope maker, and discoverer of planetary satellites and nebulae. *Richard Jakiel*

ASTRONOMY (ISSN 0091-6358, USPS 531-350) is published monthly by Kalmbach Publishing Co., 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187-1612. Periodicals postage paid at Waukesha, WI, and additional offices. POSTMASTER: Send address changes to ASTRONOMY, 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187-1612. Canada Post Publication Agreement Number 40010760.

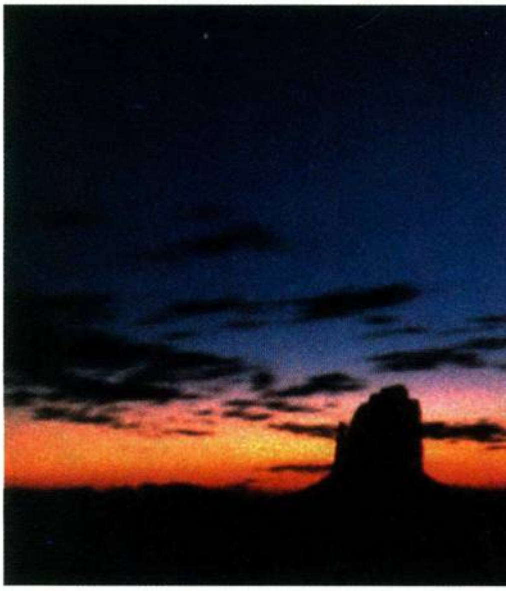


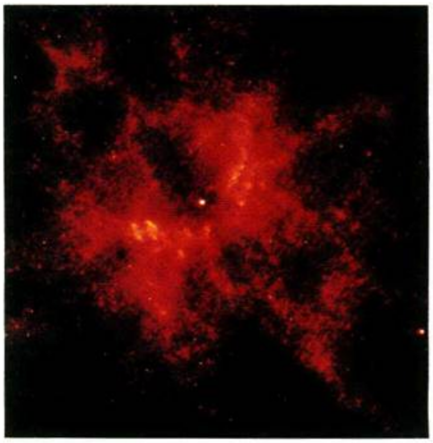
49 Exposing Saturn's Secrets

NASA/NSSDC

80 An Eye for Luxury

Astronomy: William Zubac





66 Ask Astro

S. Heap, NASA/Goddard Space Flight Center

74 Celestial Portraits

From *The Glorious Constellations*, © 1991; Harry N. Abrams, Inc.

DEPARTMENTS

6 Behind the Scenes
- Big Bang Brouhaha

12 Sky Gem

16 Talking Back

22 Astro News
- Explosion Rocks Centaurus A
- Global Cooling Strikes Pluto
- Magnetars Multiply
- A Planet Bites the Dust
- Black Holes Rage in Old Age
- Comets Split Far from Sun
- First Forecast: Cloudy; No Rain

56 Sky Show
- Saturn puts on its best show in decades, while Geminid meteors streak across the sky. *Martin Ratcliffe and Alister Ling*

66 Ask Astro

90 Star Stuff

Products
- Eclipse Timer
- Calendars Galore

Books
- *Setting Sail for the Universe*
- *Storms from the Sun*

Bytes
- The Webweaver Picks

94 Strange Universe

96 Astronomy 101

106 Looking Ahead

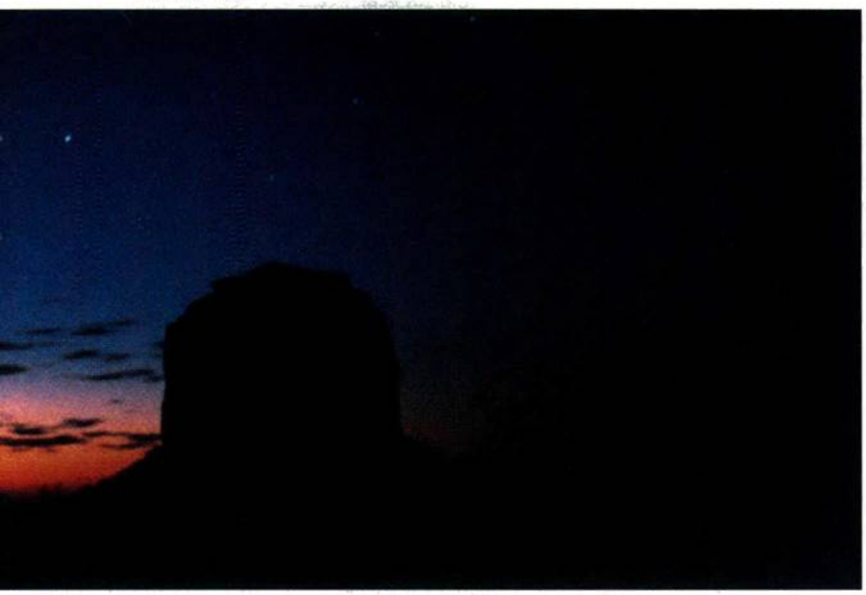
107 Advertiser Index

109 Hot Shots

112 Ultimate Exposure

INTERNATIONAL SPACE STATION
2003 Calendar
EARTH from SPACE
Hubble Space Telescope
2003 Calendar

90 Star Stuff



34 Do You Believe in the Big Bang?

Dewey Vanderhoff

42 Dodging an Asteroid

NASA/GSFC

109 Hot Shots

Fabrizio Melandri

BEHIND THE SCENES

BY DAVID J. EICHER

Big Bang Brouhaha

Let's face it, folks. Science no longer mirrors *Young Frankenstein*. The process of discovery isn't — and never really was — about "eureka" moments. Rather, it's a long, slow, collaborative effort in which an assembly line of data gets taken and analyzed by a collective soul of tens of thousands. That knowledge builds over months and years into hypotheses, and then into theories, and finally into laws. At the lower end of newly-minted hypotheses are the educated guesses — bolstered by experiments and observations — that perhaps (for instance) gamma-ray bursters are the result of colliding neutron stars. At the scale's other end are the unassailable laws such as gravity and entropy.

Since the 1960s, cosmology's prime hypothesis, the Big Bang origin of the universe, has received a wealth of supporting evidence. This is particularly true over the past decade, since the Cosmic Microwave Background Explorer satellite and other experiments have nailed down fundamental observations that the Big Bang would explain. Yet for some reason, a non-trivial slice of the scientifically-literate public seems hesitant to accept the Big Bang as fact. It's even become fashionable to doubt the entire concept's validity, despite the supporting evidence for it, because all the details of how the resulting early universe evolved aren't known yet. The cottage-industry movement of naysayers reached a peak in 1991 with the appearance of a book titled *The Big Bang Never Happened*.

But it most certainly did. On page 34 astrophysicist James Sweitzer explains why it happened, outlines the evidence for it, and describes why you should have as much confidence in the Big Bang as in the next sunrise. Until recently, Sweitzer was director of research at New York's Rose Center for Earth and Space; he is now at DePaul University in Chicago. You can determine truth any way you like: You could believe in dreams, what authorities tell you, in mathematical probabilities, or in empirical observation and experimentation. If you believe in the latter, the basis of science, then the Big Bang rests on sturdy ground.

As the numbers of known asteroids and studies of their orbits grow, we are hearing more and more about the possibility of an Earth-crossing rock someday smacking into our planet. Science writer David Chandler, a veteran contributor to the *Boston Globe*, tells the story of asteroid 1950 DA on page 42. This one-kilometer rock will swing close to our planet many times before it may come too close for comfort in 2880. The orbital resonance with Earth inherent in 1950 DA raises the question of how astronomers may ultimately deflect an asteroid from a possible Earth collision.

On a brighter note, please help welcome Anthony Belli, a talented graphic designer, to *Astronomy's* staff. Tony will work on the magazine and our sister product, Astronomy.com, bringing you excellent design and astronomical imagery. He is a former student of the Milwaukee Institute of Art and Design and has worked on Kalmbach's other magazines as well as books. Tony also has substantial experience in advertising materials and produces a monthly newspaper called *Vital Source Publication*. He enjoys spending time with his fiancé, Daeni, and their two cats. Welcome, Tony!

Yours truly,

Dave Eicher
Editor

Astronomy®

EDITOR
David J. Eicher
ART DIRECTOR
Tom Ford

EDITORIAL STAFF

SENIOR EDITOR
Richard Talcott
ASSOCIATE EDITOR
Maggie McKee
COPY AND PHOTO EDITOR
Elesa Janke
EDITORIAL ASSOCIATE
Terry Williams Conley
EDITORIAL ASSISTANT
Julie Sherwin
CONTRIBUTING EDITORS
Bob Berman, Robert Burnham, Glenn F. Chaple, Jr., Phil Harrington, Ray Jayawardhana, Steve Nadis, Tom Polakis, John Shibley, William Schomaker

ART STAFF

GRAPHIC ARTIST
Anthony Belli
ILLUSTRATOR
Elisabeth Rowan
PRODUCTION COORDINATOR
Helene Tsigistras

EDITORIAL ADVISORY BOARD

Buzz Aldrin, Marcia Bartusiak, Timothy Ferris, Alex Filippenko, Adam Frank, William K. Hartmann, Paul Hodge, John S. Gallagher III, Anne L. Kinney, Edward Kolb, Stephen P. Maran, S. Alan Stern, James Trefil

ASTRONOMY.COM

EDITOR
Andrea Gianopoulos
ASSOCIATE EDITOR
Vanessa Thomas
EDITORIAL ASSISTANT
Jeremy McGovern

http://www.astronomy.com

The Audit Bureau

Editorial phone: (262) 796-8776; advertising: (888) 558-1544; customer service & sales: 800-533-6644; outside the U.S. and Canada: 262-796-8776, ext. 421, Monday through Friday, 8:30 A.M. to 5 P.M. CT, Fax: (262) 796-1615; E-mail: customerservice@kalmbach.com. Please include your name, mailing address, and telephone number with any correspondence.

Copyright © 2002 Kalmbach Publishing Co., all rights reserved. Material in this publication may not be reproduced in any form without permission.

Printed in the U.S.A. Allow 6 to 8 weeks for new subscriptions and address changes. Subscription rate: single copy: $4.95; 1 year $39.95, 2 years (24 issues) $74.95, 3 years (36 issues) $106.95; Canadian & foreign: 1 year $50, 2 years $95, 3 years $137. Payable in U.S. funds drawn on U.S. Banks. (Canadian price includes GST.) Expedited Delivery Service Surcharges: Domestic 1st Class $30 per year, Canadian air $30 per year, Foreign air, $60 per year. BN 12271 3209 RT. Not responsible for unsolicited materials.

70 • 90 • 105 • 125 ETX MEADE® AUTOSTAR

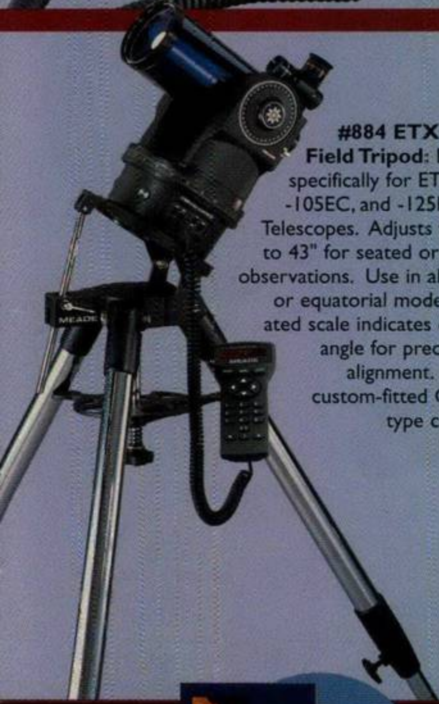
ETX-90EC
$495

ETX-70AT
$299

ETX-125EC
$895

ETX-105EC
$695

ETX-90EC, -105EC, and -125EC shown with optional #497 Autostar Controller


#884 ETX Deluxe Field Tripod: Designed specifically for ETX-90EC, -105EC, and -125EC Astro Telescopes. Adjusts from 25" to 43" for seated or standing observations. Use in altazimuth or equatorial modes; graduated scale indicates elevation angle for precise polar alignment. Includes custom-fitted Cordura-type carry bag.
$199.95

Meade ETX telescopes are the largest-selling modern telescopes in the world, with hundreds of thousands of ETX's now in the field. And every one with the unique ETX trademarks: matchless diffraction-limited optical performance; ultra-portable, contemporary design; and revolutionary Autostar GO TO capability. *See the Meade General Catalog for full details.*

MEADE ETX ASTRO TELESCOPES

Complete per catalog specifications:

ETX-70AT with #494 Autostar and #882 Field Tripod	$299
ETX-90EC with Electronic Controller	495
ETX-105EC with Electronic Controller	695
ETX-125EC with Electronic Controller	895
#497 Autostar controller for ETX-90EC, ETX-105EC, or ETX-125EC	149

Ultra-High Transmission Coatings (UHTC) group increases image brightness by about 20%: ETX-90EC– $50; ETX-105EC– $75; ETX-125EC– $95

Prices shown are suggested U.S. mail-order retail prices.

Buy a $650 Super Plössl eyepiece set for your ETX for only $99!

Through November 30, 2002, buy a full set of Meade premium-grade Series 4000 Super Plössl eyepieces, packed in a Meade #771 aluminum carrying case, for only **$99** with the purchase of any Meade ETX-90EC, -105EC, or -125EC telescope.

See the full-page Meade ad in this issue for complete terms and conditions of this amazing offer.

New 2002 Meade General Catalog!
Call, write or fax for your free copy.

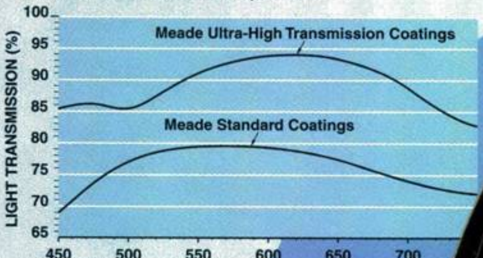
ADVANCED PRODUCTS DIVISION
Meade Instruments Corporation
The largest-selling telescopes in the world. ■ A NASDAQ® company.
6001 Oak Canyon, Irvine, California 92618 ■ (949) 451-1450
1-800-62-MEADE ■ FAX: (949) 451-1460 ■ *www.meade.com* © 2002

LXD55

MEADE

Choose from nine Meade Schmidt-Newtonians, Schmidt-Cassegrain, and Achromatic Refractors, each with Autostar® or Electronic Controller — from $579, *complete!*

Meade Ultra-High Transmission Coatings (UHTC) Group: Available optionally at the time of telescope purchase, the UHTC group increases image brightness by about 20% over the visible spectrum.



Observe ***hundreds*** of galaxies, nebulae, and star clusters of all types ***your very first night out,*** and hundreds more the next night out, simply by pressing the Autostar GO TO pushbutton. Watch as the telescope fast-slews at 4.5°/second, locating each object — from the brightest to the most obscure — and placing it automatically, unerringly, and precisely in the telescopic field. Or choose one of the new EC-models with dual-axis Electronic Controller, telescopes upgradable at any time in the future to full GO TO status just by adding the Autostar hand controller.

MEADE
LXD55
MEADE
LXD55

Meade Model SC-8
8" f/10 Schmidt-Cassegrain Telescope with standard-equipment Autostar Control System.
Complete as shown: **$1195.**

Meade Model SN-8
8" f/4 Schmidt-Newtonian Telescope with standard-equipment Autostar Control System.
Complete as shown: **$839.**

Buy a $650 Super Plössl eyepiece set for your LXD55 telescope for only $99! ***See ad in this issue for details!***

6", 8", and 10" LXD55-Series Schmidt-Newtonians with Autostar

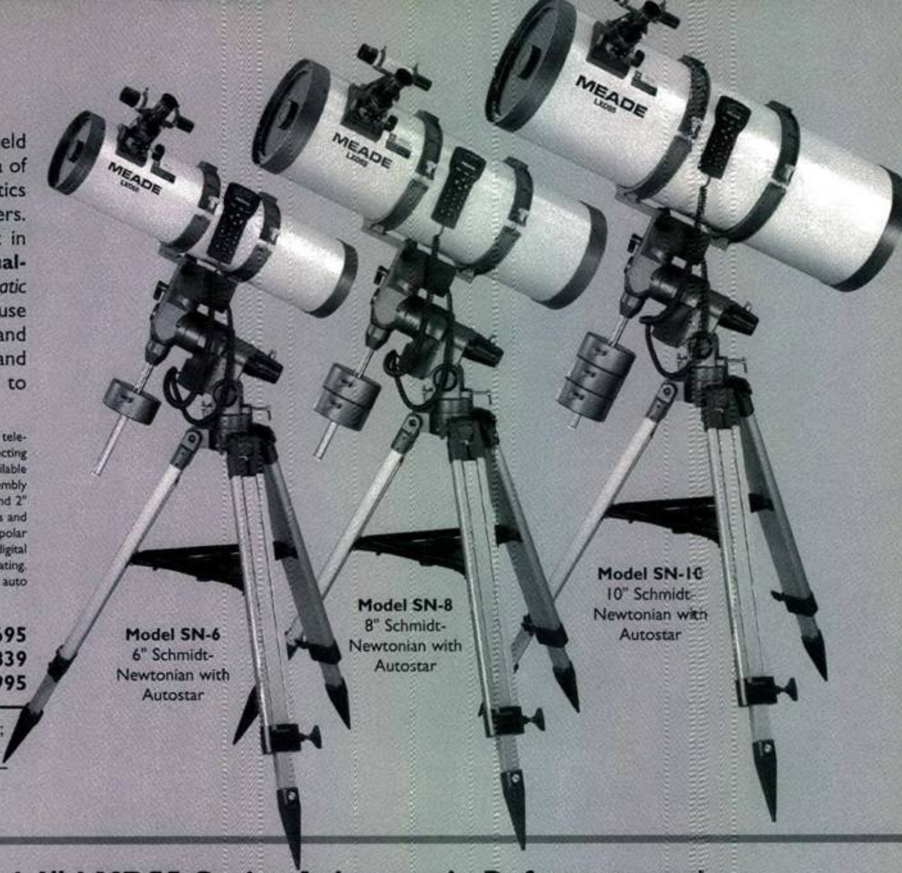
Meade American-made diffraction-limited Schmidt-Newtonian optics yield pinpoint stellar images over extremely wide fields, with *one-half* the coma of paraboloids of the same focal ratios. Fast f/4 (8", 10") or f/5 (6") optics present brilliant, rich-field imaging of nebulae, galaxies, and star clusters. High-power lunar and planetary images reveal subtle detail often lost in telescopes of lesser resolution. The standard-equipment **Autostar Dual-Axis Control System** permits an amazing range of operations: *automatic GO TO capability* at 4.5°/second to 30,223 database objects (galaxies; diffuse and planetary nebulae; star clusters; the complete Messier, Caldwell, IC, and NGC catalogs; double and variable stars; eight major planets; asteroids; and comets); *nine selectable slew and slow-motion speeds* from 1x sidereal to 4.5°/sec.; plus *automatic sidereal-rate tracking* in RA, and much more.

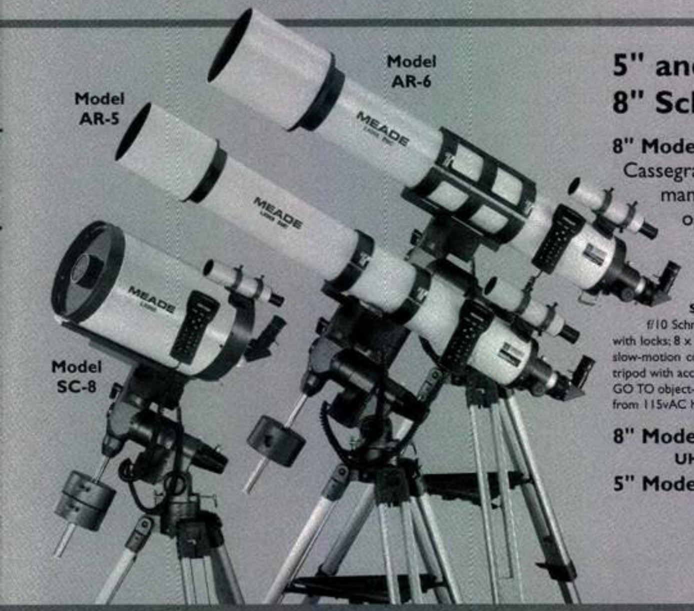
SPECIFICATIONS: Models SN-6, SN-8, and SN-10 Schmidt-Newtonian Telescopes — Each complete telescope includes 6" f/5, 8" f/4, or 10" f/4 Schmidt-Newtonian optical tube assembly with MgF_2 coatings on the correcting lens and standard aluminum coatings on the primary and secondary mirrors (Ultra-High Transmission Coatings available optionally); white-enameled metal optical tube with machined-aluminum mirror cell; quick-release cradle ring assembly with locks; 6 x 30mm achromatic viewfinder; metal rack-and-pinion focuser with eyepiece holders for both 1.25" and 2" eyepieces; Series 4000 Super Plössl 26mm eyepiece. LXD55 German-type equatorial mount with worm gear drives and electric slow-motion controls on both axes; micrometric controls for azimuth and elevation adjustments; illuminated polar alignment finder with reticle; variable-height field tripod with accessory shelf. Autostar dual-axis control system with digital readout display; 9-speed drive controls; 30,223-object celestial software library and automatic GO TO object-locating. Battery pack accepting eight (user-supplied) D-cells (optional 25 ft. cords permit powering from either 12v DC auto cigarette lighter plug or from 115v AC home outlet); operating instructions.

6" Model SN-6 Schmidt-Newtonian	**$695**
8" Model SN-8 Schmidt-Newtonian	**839**
10" Model SN-10 Schmidt-Newtonian	**995**

Ultra-High Transmission Coatings (UHTC) group: 6" Model SN-6 – $85; 8" Model SN-8 – $125; 10" Model SN-10 – $150.

Packing & shipping charges in the 48 states: 6" – $75; 8" – $85; 10" – $95.


MEADE
MEADE
MEADE
Model SN-6
6" Schmidt-Newtonian with Autostar
Model SN-8
8" Schmidt-Newtonian with Autostar
Model SN-10
10" Schmidt-Newtonian with Autostar



5" and 6" LXD55-Series Achromatic Refractors and 8" Schmidt-Cassegrain with Autostar

8" Model SC-8: Includes the f/10 optical system of the Meade 8" LX200GPS for razor-sharp Schmidt-Cassegrain photo-visual imaging of the Moon, planets, and deep-space. All the telescope required by many amateurs for a lifetime of serious observing. **5" Model AR-5, 6" Model AR-6:** Excellent optical performance from the classical 2-element achromat design, with images rich in resolution and contrast and a minimum of chromatic aberration. Models SC-8, AR-5, and AR-6 allow for the full range of Autostar functions described above.

SPECIFICATIONS: Models SC-8 Schmidt-Cassegrain and AR-5 and AR-6 Achromatic Refractors — Each complete telescope includes 8" f/10 Schmidt-Cassegrain with MgF_2/standard coatings or 5" f/9 or 6" f/8 achromatic refractor with EMC super multi-coatings; quick-attach cradle ring assembly with locks; 8 x 50mm viewfinder; Series 4000 Super Plössl 26mm eyepiece; diagonal prism. LXD55 German-type equatorial mount with worm gear drives and electric slow-motion controls on both axes; micrometric controls for azimuth and elevation adjustments; illuminated polar alignment finder with reticle; variable-height field tripod with accessory shelf. Autostar dual-axis control system with digital readout display; 9-speed drive controls; 30,223-object celestial software library and automatic GO TO object-locating. Battery pack accepting eight (user-supplied) D-cells (optional 25 ft. cords permit powering from either 12vDC auto cigarette lighter plug or from 115vAC home outlet); operating instructions.

8" Model SC-8 Schmidt-Cassegrain	**$1195**
UHTC group for Model SC-8 — $175	
5" Model AR-5 Achromatic Refractor	**695**
6" Model AR-6 Achromatic Refractor	**895**

Packing & shipping charges in the 48 states: 8" – $85; 5" – $85; 6" – $95.

6" and 8" LXD55-Series Schmidt-Newtonians and 5" Achromatic Refractor with Electronic Controller

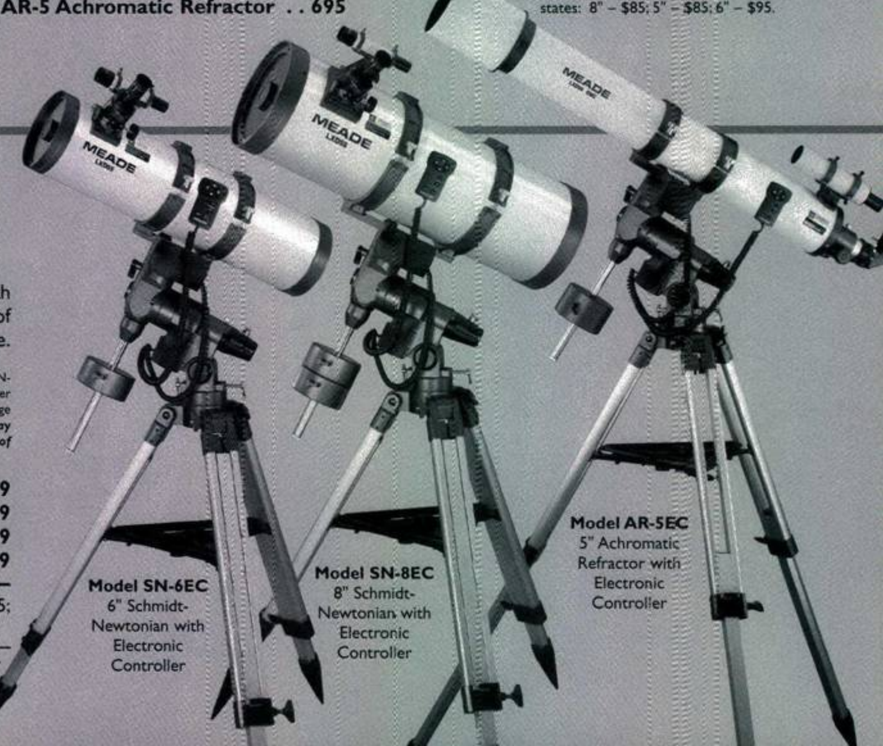
All the performance and features of the Autostar models above, but with 4-speed (2x, 8x, 32x, 4.5°/sec.) dual-axis Electronic Controller in place of Autostar. Upgrade to the Autostar Controller, available separately, at any time.

SPECIFICATIONS: Models SN-6EC, SN-8EC, and AR-5EC — Identical in every detail to the respective Models SN-6, SN-8, and AR-5, above, but with Electronic Controller (EC) in place of Autostar Hand Controller. Electronic Controller includes four dual-axis slewing speeds: 2x for photoguiding; 8x for image centering in the main telescope; 32x for image centering in the viewfinder; and 4.5°/second for rapid-slew of the telescope across the sky. ***#497 Autostar Controller may be added at any time in the future and, when plugged into the telescope's control panel, permits the full range of Autostar functions, including automatic GO TO, as described for Autostar-equipped telescopes, above.***

6" Model SN-6EC Schmidt-Newtonian	**$579**
8" Model SN-8EC Schmidt-Newtonian	**699**
5" Model AR-5EC Achromatic Refractor	**579**
#497 Autostar Controller, for any EC-model above	**149**

Ultra-High Transmission Coatings (UHTC) group: 6" Model SN-6EC – $85; 8" Model SN-8EC – $125.

Packing & shipping charges in the 48 states: 6" SN-6EC – $75; 8" SN-8EC – $85; 5" AR-5EC – $85. All prices shown in this ad are suggested U.S. national mail-order retail prices. © 2002


MEADE
MEADE
MEADE
Model SN-6EC
6" Schmidt-Newtonian with Electronic Controller
Model SN-8EC
8" Schmidt-Newtonian with Electronic Controller
Model AR-5EC
5" Achromatic Refractor with Electronic Controller

MEADE®

RESEARCH-GRADE ACCESSORIES

Series 4000™ Super Plössls
52° field; multi-coated

Meade 4-element Super Plössls, updated and redesigned to utilize the latest in optical glass-types, are the finest general-purpose eyepieces available. For observing hairline lunar and planetary detail, splitting close doubles, or studying tenuous nebulosity in deep-space, Meade SP's deliver unmatched contrast and image sharpness. Rubber eyeguards fold down for eyeglass wearers–a feature not available on competing brands. Multi-coated. All focal lengths through 32mm are parfocal.

Super Plössls (SP; 4-elements; 1.25"; 52°):

6.4, 9.7, 12.4, 15, 20, 26mm	each: **$79.95** (4.54)
32mm (52°); **40mm** (44°)	each: **99.95** (5.26)
56mm (52°; 2")	**199.95** (7.02)

Series 4000™ Ultra Wide Angle
84° field; multi-coated

The ultimate eyepieces; extreme image sharpness over an amazing 84° field. A perfect optical match with Schmidt-Cassegrains and fast Newtonians.

Ultra Wide Angle (UWA; 8-elements; 1.25"; 84°)– **4.7mm: $169.95** (5.26); **6.7mm: 199.95** (5.26); **8.8mm** (1.25"/2"): **239.95** (7.02); **14mm** (1.25"/2"): **299.95** (7.02)

Series 4000™ f/6.3 Focal Reducer/ Field Flattener

Manufactured to exclusive Meade optical designs; threads on to any Meade or Celestron Schmidt-Cassegrain rear cell and converts f/10 scopes to f/6.3 (or f/6.3 SCT's to f/4), while significantly flattening the field. Use with SCT visual or photo accessories. Actual visual field is increased by 56%, for fine wide-field views of star fields and nebulae. In astrophotography, reduces exposure times by about 50%, while producing an actual field diameter of 1.5" at the film plane. A tremendous aid with CCD imagers in reducing image size for locating and centering images on CCD chips. 4-element optics; multi-coated; 41mm clear aperture.

$129.95 (5.26)

2x Telenegative Barlow (1.25")

#122: Doubles eyepiece power with sharp, high-resolution, high-contrast imaging on telescopes of all types. 27mm dia. (26mm clear aperture). Excellent corrections for chromatic and spherical aberrations at all photo-visual wavelengths. Multi-coated. 1.25"

$47.95 (4.54)

2x Short-Focus Barlow (1.25")

#126: Only 2.5" long, the #126 works well with any telescope accepting 1.25" eyepieces, even those with limited focus range. Maintains the high image quality of the #122, above. Insert the #126 into star diagonal for 2x or insert star diagonal into #126 for 3x. 26mm clear aperture. Multi-coated.

$47.95 (4.54)

2x-3x Variable Barlow (1.25")

#127: Precision internal sliding lens assembly permits continuously variable power settings between 2x and 3x. Engraved scale indicates power in use. Yields bright, sharp, high-contrast images on telescopes of all types. Multi-coated; 1.25".

$59.95 (4.54)

2" Diagonal Mirror

#929: Permits use of wide-field 2" oculars. Threads on to rear cell of Meade and Celestron SCT's. Includes UHTC-coated (95%+ reflectivity) precision optical flat made at the Meade factory; with 1.25" eyepiece adapter. **#930:** Same as #929 but with 2" barrel to fit into focusers with 2" eyepiece-holders.

#929 or **#930,** each: **$99.95** (6.85)

45° Erecting Prisms

Fully coated roof prisms to invert the astronomical image in Schmidt-Cassegrains or refractors during terrestrial observations, while presenting a convenient 45° observing angle. Specify **#927** (.965"), **#928** (1.25"), or **#931** (fits .965" focuser, accepts 1.25" eyepieces).

$42.95 (3.86)

World's Most Advanced Illuminated Reticle Eyepiece

Series 4000 Plössl 9mm, with rubber eyecup and micrometric X-Y positioning of the reticle within the field. Greatly facilitates locking on the guide star. Sharp high-power imaging, excellent eye relief. Wireless red LED illuminator with adjustable brightness control. Multi-coated optics. **Internal batteries included.** Bullseye reticle. 1.25".

$149.95 (6.14)

Series 4000 Plössl 9mm—Same as above but with 6 ft. cord and plug for Meade LX3, LX5, LX6, LX100, LX200, and APO power panels, in place of wireless illuminator.

$129.95 (5.26)

Series 4000 Photo-Visual Color Filters (1.25")–Premium filters, made of purest crown optical glass, dyed in the mass. For increased contrast and resolution on the Moon and planets. Thread into the barrels of virtually all 1.25" eyepieces sold today. Fully coated.

#8 Lt. Yellow; #11 Yellow Green; #12 Yellow; #21 Orange; #23A Lt. Red; #25A Red; #38A Dark Blue; #47 Violet; #56 Lt. Green; #58 Green; #80A Blue; #82A Lt. Blue

each **$14.95** (2.73)

Set #1–4 filters: #12, #23A, #58, #80A	**49.95** (4.54)
Set #2–4 filters: #11, #25A, #47, #82A	**49.95** (4.54)
Set #3–4 filters: #8, #21, #38A, #56	**49.95** (4.54)

Series 4000 Moon Filter (#ND96): Reduces glare and irradiation during lunar observing. 13% uniform light transmission across the visual spectrum. Threads into 1.25" barrels.

$16.95 (2.73)

#905 Variable Polarizer (1.25")

For glare reduction in observing the Moon. Includes two Polarizer filters mounted in a machined cell and permits continuously variable light transmission from 5% to 25%, to compensate for varying lunar surface brightness according to the Moon's phase and the aperture of the telescope. Accepts 1.25" eyepieces.

$49.95 (5.26)

Electric Focusers for SCT's

For extremely smooth microfocusing of the image. Does not affect use of the manual coarse-focus knob.

#1206 Electric Focuser: Plugs into control panel of Meade 8", 10", 12" LX200 models and operates from LX200 hand controller. (Not for LX200GPS models.)

$149.95 (7.48)

#1205 Electric Focuser: For **all** other Meade 8", 10", 12" SCT models; includes separate hand controller; accepts one self-contained (user-supplied) 9v. battery.

$169.95 (7.88)

#777 Off-Axis Guider for SCT's

Internal prism diverts light for monitoring telescopic image during long-exposure astrophotography. Threads to any Meade or Celestron rear cell. Use with illuminated reticle eyepiece and T-Mount for your 35mm camera.

$79.95 (6.85)

Series 4000™ 2x Apochromatic Barlow Lens

#140: The most advanced Barlow lens available for commercial telescopes, the Meade #140 includes 3-element, multi-coated, air-spaced optics. Doubles the power of any eyepiece with which it is used and yields images absolutely unmatched in resolution, contrast and color correction. The #140 optically complements any telescope — refractor, reflector, or Schmidt-Cassegrain. Accepts 1.25" eyepieces. Mechanical components are of machined aluminum and brass. Lens diameter is 28mm; clear aperture 26mm.

$79.95 (5.26)

Series 4000™ Super Wide Angle
67° field; multi-coated

For exquisite wide-angle images at low-to-medium powers, with pinpoint edge-of-field resolution. Ideal for star fields, galaxies, and other deep-space phenomena. SWA 13.8mm, 18mm, and 24.5mm are superb complements to the #140 Barlow, above.

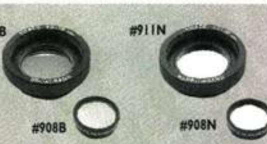
Super Wide Angle (SWA; 6-elements; 1.25"; 67°)–**13.8mm: $139.95** (4.54); **18mm: 149.95** (4.54); **24.5mm: 179.95** (5.26); **32mm** (2"): **239.95** (7.02); **40mm** (2"): **299.95** (7.02)

Series 3000™ Plössls
50° field; multi-coated

Meade Series 3000 Plössls yield the finest image corrections obtainable from the classical 4-element Plössl design. Focal lengths from 5mm through 25mm are parfocal, so that, at most, only slight refocusing of the image is necessary from eyepiece to eyepiece. Unlike competing moderately-priced Plössls, Meade Series 3000's are **multi-coated** for maximum light transmission and image contrast. Chrome-plated brass barrels are threaded for standard filters. All eyepieces are fitted with fold-down rubber eyecups for comfortable observing. The PL40mm *(far right in photo)*, an excellent complement to any ocular set, produces spectacular low-power, wide fields, ideal for scanning the Milky Way. Manufactured exclusively to Meade optical designs, Series 3000 Plössls yield fine, high-resolution results on reflectors, refractors, and Schmidt-Cassegrains of any focal ratio.

Series 3000 Plössls (4-elements; 1.25"; 50°)

5, 6.7, 9.5, 16, 25mm each: **$49.95** (3.86); **40mm $79.95** (3.86)



Series 4000 Nebular Filters—Premium multi-layer interference filters, the finest obtainable. Use broadband ("B") filters to block most forms of light pollution; use narrowband ("N") filters in heavily light-polluted areas or for extremely high-contrast observing of faint nebulae.

#908B–Threads into 1.25" eyepieces, 26mm dia.	**79.95** (4.54)
#911B–Threads on to rear cell of Schmidt-Cassegrain telescopes. 36mm dia.	**99.95** (5.26)
#908N–Threads into 1.25" eyepieces, 26mm dia.	**89.95** (4.54)
#911N–Threads on to rear cell of Schmidt-Cassegrain telescopes. 36mm dia.	**119.95** (5.26)

Series 4000 Oxygen-III Filters Observe diffuse emission and planetary nebulae as you never thought possible! Exclusive Meade 60-layer interference coating technology isolates the 496nm and 501nm O-III lines to tremendously enhance observable nebular structural detail in all telescopes.

#908X–Threads into 1.25" eyepieces, 26mm dia.	**99.95** (4.54)
#911X–Threads on to rear cell of Schmidt-Cassegrain telescopes. 36mm dia.	**149.95** (5.26)

Vibration Isolation Pads

Designed by Meade engineers, these isolation pads reduce typical telescope-tripod vibration damping times to *less than one second.* A tremendous aid for both visual and photographic astronomy. Place one pad under each tripod leg. #895 Vibration Isolation Pads, per set of three:

$49.95 (6.85)

MA12mm Illuminated Reticle Eyepiece

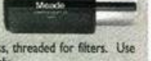
Excellent 3-element optical system, long eye relief, fully coated, with double crossline reticle; rubber eyecup. Wireless red LED illuminator and variable brightness control. 1.25". **Batteries included.**

$99.95 (3.45)

As above but with 6 ft. cord and plug for Meade telescopes with power panels, in place of wireless illuminator.

$79.95 (5.26)

Camera Adapters



Professional-quality adapters for rigid coupling of telescope-to-camera. Use for either Eyepiece-Projection or Prime Focus. Precision-machined of aluminum and brass, threaded for filters. Use with T-mount, available separately.

.965": **$27.95**; 1.25": **$29.95** (3.86)

Variable-Projection Camera Adapter (1.25")

Machined sliding cell allows variable projection power in eyepiece-projection photography; permits precise selection of correct photo power in lunar and planetary photography; threaded for filters. Use with T-mount for your camera.

$39.95 (3.86)

Variable Tele-Extender

For eyepiece-projection photography with any Meade or Celestron SCT. Threads on to eyepiece-holder. Sliding cell with lock permits wide range of projection magnifications with the same eyepiece. Use with T-mount for your camera.

$39.95 (3.86)

T-Adapters for SCT's

Rigidly couples camera to telescope for prime focus photography with any Meade or Celestron Schmidt-Cassegrain. Use with T-Mount for your 35mm camera.

$26.95 (3.86)

CCD-Photo-Visual Flip-Mirror Systems

An essential accessory for imaging with **any** brand of CCD imager or for astrophotography with a 35mm camera. Flip mirror "down" to center the image while viewing with an eyepiece at 90°; flip mirror "up" to pass light on to CCD chip or 35mm camera film plane. Each unit includes: precision optical-flat Pyrex® mirror; 2-axis mirror-adjustment screws and locks for precise image centering; extra-fine helicoid focusing of the eyepiece; extension tubes for attaching either 35mm camera (using T-Mount) or CCD imager (using either T-threads or 1.25" barrel). Threads to rear cells of all *Schmidt-Cassegrain* telescopes; may remain on telescope and used in place of diagonal prism for visual observing as well.

> *"Over the past 10 years I have used all manner of flip-mirrors. The Meade Flip-Mirror Systems are absolutely the best—rock solid, high-precision, beautifully manufactured; they virtually eliminate all flexture between the CCD and telescope."* — Jack Newton

#644 Flip-Mirror System: Accepts any 1.25" eyepiece. Mirror clear aperture: 22mm. Use with CCD's up to Pictor 416XTE, ST-7, or AP1, or smaller; or visual observing with 1.25" eyepieces.

$149.95 (7.02)

#647 Flip-Mirror System: Accepts either 1.25" or 2" eyepieces. Mirror clear aperture: 40mm. Recommended for full-field 35mm astrophotography or with CCD's of any size, including all Meade Pictor Series through 1616XTE, or ST-4 through ST-10; or AP2, AP7; or for visual applications with 1.25" or 2" eyepieces.

249.95 (8.49)

#157 1.25" Adapter: Permits use of either Flip-Mirror on telescopes with 1.25" eyepiece-holders. (Requires approx. 7" additional focus travel with #644, 3" with #647.)

15.00 (3.86)

#1209 Zero Image-Shift Microfocuser

Identical to the Microfocuser supplied with Meade LX200GPS telescopes, but provided with a separate hand-box for use with all other Meade SCT models (e.g., LX10, LX50, LX90, LX200) or for Schmidt-Cassegrains of other brands. Threads directly to the telescope's rear cell. Permits extremely precise focusing of the image during visual or photographic applications; during CCD applications maintains precise image centration on even the smallest CCD chips. Operates at four speeds, from extremely slow to fast; accepts both 2" and 1.25" eyepiece barrels. Requires 8 x AAA (user-supplied) batteries.

$249.95 (9.85)

Epoch 2000® Sky Software

The most powerful astronomical software ever made available can now be yours for only $99!

Epoch 2000sk *(upper display at left)*: Use the most advanced, most precise full-color sky software ever created, to zoom-in on telescopic fields **smaller than one arc second!** Dynamically reads out the R.A. and Dec. of the cursor position anywhere in the field **and updates R.A. and Dec. instantaneously as the cursor is moved about the field.** Meade LX200 owners can use Epoch 2000sk for remote auto-centering of objects in the telescopic field **to a precision of 30 arc seconds,** routinely! Print professional-quality star charts in either black-and-white or color, at any zoom setting or sky scale between 180° and one arc second, with your own customized borders, headers, footers, margins, fonts, colors, and grids.

Epoch 2000ip Image Processing Software: Enhance and analyze your CCD images with the same sophisticated techniques used by professional astronomers to uncover hidden structure in a spiral galaxy or obscure detail on the surface of a planet.

EPOCH 2000sk Sky Software: 19 million objects, including the complete Hubble Guide Star Catalog; supplied on CD-ROM for Windows 95, 98, 2000, NT, and XP **$99**

LX200 Interface Cable: for Meade LX200/LX200GPS operation by Epoch 2000sk.......... **25**

EPOCH 2000ip Image Processing Software: On CD-ROM for Windows 95, 98, 2000, NT, and XP.... **99**

Series 4000™ f/3.3 CCD Focal Reducer/Field Flattener

Revolutionary 3-element Meade design permits ultrafast CCD imaging with **increased** edge-of-field resolution and color correction! Reduces CCD exposure times by up to 80%. Threads on to the rear cell of any Meade or Celestron Schmidt-Cassegrain. Converts f/10 Schmidt-Cassegrain telescopes to **f/3.3** and f/6.3 SCT's to **f/2.** Variable T-Adapter (included) allows range of f/ratios between f/3 and f/5 on f/10 SCT's and between f/1.9 and f/3.2 on f/6.3 SCT's. Use with CCD imagers of any brand and chip dimensions. Not for visual or photographic applications. Multi-coated; 41mm clear aperture.

$149.95 (5.26)

Plössl 25mm Illuminated Reticle CCD Framing Ocular

Displays rectangular frames of all popular CCD chip sizes, including all Meade Pictor models; ST-4 through ST-8; AP1, AP2; and others. Shows precisely the image size and orientation that appear on CCD chip. Insert directly into telescope eyepiece-holder, or use with Flip-Mirror *(above)*. Includes 4-element coated Plössl optics; lockable spacer ring to fix focus position; rubber eyecup; variable LED illumination control; batteries. 1.25".

$129.95 (4.54)

#825 8 x 25mm Right-Angle Viewfinder for ETX-90

Permits comfortable right-angle viewing. Replaces standard-equipment finder on 90mm ETX models, using the same bracket. Wide-angle, achromatic, coated optics; actual field 7.5°. Precise helicoid focusing.

$49.95 (4.26)

#64 T-Adapter for ETX®

Threads to photo port of all ETX-90, ETX-105, and ETX-125 models. Rigidly couples any 35mm camera with removable lens to the telescope for lunar, planetary, or terrestrial photography. Includes extension tube for longer effective focal length, if desired. Use with T-Mount for your 35mm camera.

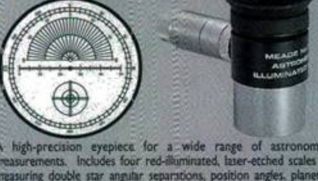
$34.95 (3.86)

#932 45° Erecting Prism for ETX®

For terrestrial observing with any ETX-90, ETX-105, or ETX-125 model. Yields correctly oriented image and convenient 45° observing angle. Threads to ETX rear cell. Accepts any 1.25" eyepieces. Coated roof prism optics.

$49.95 (3.86)

MA12mm Illuminated Reticle Astrometric Eyepiece



A high-precision eyepiece for a wide range of astronomical measurements. Includes four red-illuminated, laser-etched scales for measuring double star angular separations, position angles, planetary diameters, and lunar crater diameters, and for long-exposure photo-guiding. Modified Achromatic 3-element coated optics; diopter adjustment; rubber eyecup; variable LED illumination control; batteries. 1.25".

$119.95 (4.26)

Series 4000™ 8mm – 24mm Zoom Eyepiece

The finest zoom eyepiece available. High-resolution 7-element multi-coated optics, with 55° field at 8mm. Graduated scale in 1mm units indicates exact focal length in use. High-eyepoint yields comfortable observing even with eyeglasses. Internal zoom lenses move on the smoothest, most precisely-machined tracks yet developed for zoom optics. Performance is fully consistent with the finest fixed-focal length eyepieces. Threaded for filters; rubber eyecup; 1.25".

$219.95 (6.38)

ETX® Hard Carrying Cases

For secure storage or travel with your ETX. Thick-wall construction and die-cut foam lining. Accepts telescope, optional eyepieces, erecting prism, table tripod, hand controller, etc. Includes steel latches & key.

#774 Case for ETX-90 models: **99.95** (8.58)

#776 Case for ETX-105EC: **99.95** (8.58)

#775 for ETX-125EC: **149.95** (13.38)

Dew Shields for ETX®

Threads into the front-lens cell and effectively inhibits the formation of dew on the lens surface.

#670 for ETX-60/70 .... **19.95**
#673 for ETX-90 .... **24.95**
#675 for ETX-105 ...... **27.95**
#678 for ETX-125 ...... **29.95**

Pictor 216XT CCD Autoguider/Imager

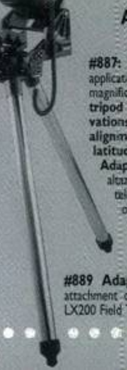
The most advanced Autoguider/Imager in its price class. For many, all the CCD imager required for a wide range of lunar, planetary, or deep-space applications. Includes the same "point-and-shoot" simplicity of larger Pictor models. Produces smooth, natural 16-bit images of all celestial subjects. Also a precision autoguider during astrophotography.

$695. (12.00)

ETX® Deluxe Field Tripod

#884: Constructed of strong, lightweight steel; designed specifically for ETX-90, ETX-105, and ETX-125 Astro Telescopes. Tripod height adjusts from 25" to 43", for seated or standing observations. Graduated scale for elevation angle from 20° to 90° permits precise polar alignment of the telescope for astronomical applications. Tripod tilts and locks at 90° for terrestrial applications or for altazimuth use with Autostar. Telescope attaches to tripod in seconds with 2 thumbscrews. **Includes custom-fitted carry bag (shown) with pocket for accessories.**

$199.95 (10.00)



Advanced Field Tripod for ETX-125

#887: Yields rock-solid stability for sensitive applications of the ETX-125, even at high magnifications. **Includes fixed-height tripod convenient for standing observations, equatorial wedge with alignment controls in azimuth and latitude angle, and #889 Tripod Adapter for ETX-125.** Permits either altazimuth or equatorial orientation of the telescope for astronomical or terrestrial observing. Tripod legs are 2"-diameter chromed steel. For field use the tripod collapses for easy transport.

$349.95 (14.00)

#889 Adapter: Available separately, permits attachment of ETX-125 to any Meade LX10 or LX200 Field Tripod or wedge. **$69.95** (7.70)

#771 Aluminum Carrying Case

High-quality, lightweight aluminum, suitable for storage of eyepieces, camera adapters, filters, etc. Fully foam-lined. 15" x 10" x 5".

$49.95 (5.78)

Electric Focusers for ETX®

Meade-engineered for smooth, rapid focusing with ETX-90, -105, or -125. Four-speed operation from coarse to microfine. Standard-equipment hand controller accepts one 9v. (user-supplied) battery and focuses all ETX telescopes. Or focus through the telescope's Electronic Controller (EC) or through Autostar.

#1244 Electric Focuser for all ETX-90 and ETX-105 models: **$119.95** (6.85)

#1247 Electric Focuser for ETX-125 models: **$119.95** (6.85)

HOW TO ORDER

Prices shown are suggested U.S.A. mail-order retail prices and do not include any applicable sales taxes. Suggested shipping and handling charges to the 48 states by U.P.S. or U.S. Mail shown in ( ) next to each price. **The following national mail-order dealers carry Meade accessories in-stock for immediate shipment:**

ASTRONOMICS, Norman, OK.
Orders: 800-422-7876; Info.: 405-364-0858.

OCEANSIDE PHOTO & TELESCOPE, Oceanside, CA.
Orders & Information: 800-483-6287.

ANACORTES TELESCOPE, Anacortes, WA.
Orders & Information: 800-850-2001.

RIVERS CAMERA, Dover, NH.
Orders: 800-245-7963; Info.: 603-742-4888.

FOCUS CAMERA, Brooklyn, NY.
Orders: 800-221-0828; Info.: 718-436-6262.

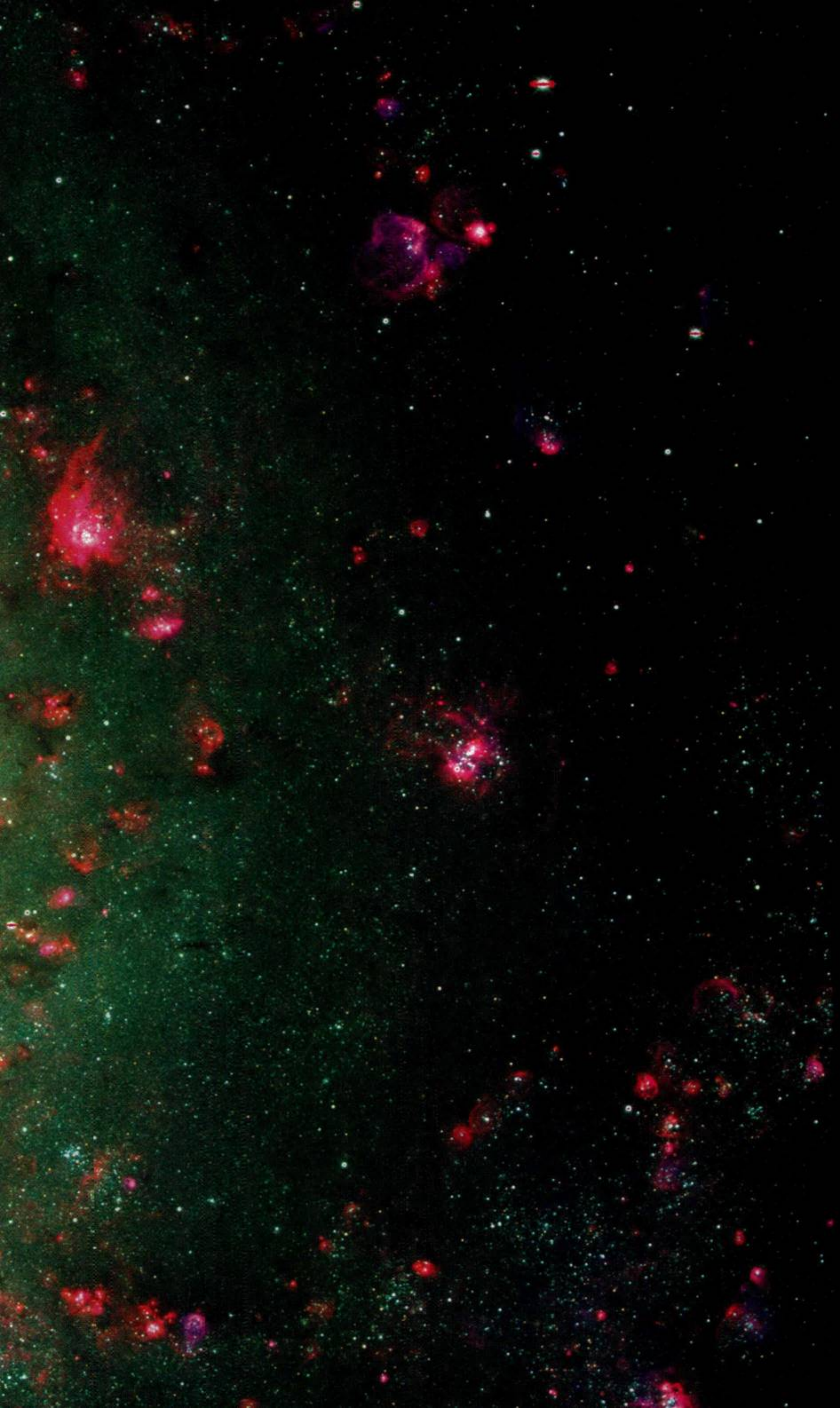
SHUTAN CAMERA & VIDEO, Chicago, IL.
Orders & Info.: 800-621-2248; IL: 847-367-4600.

WOODLAND HILLS CAMERA & TELESCOPE, Woodland Hills, CA. Orders: 888-427-8766; Info.: 818-347-2270.

EFSTONSCIENCE, Toronto, Ontario, Canada
Orders & Information: 416-787-4581.

KHAN SCOPE CENTRE, Toronto, Ontario, Canada
Orders & Information: 416-783-4140.

© 2002



sky Gem

Facing the Pinwheel

Bright red stellar nurseries trace the spiral arms of the Pinwheel Galaxy (M33) in Triangulum. This image of the nearby galaxy's central regions was taken with the 4-meter Mayall Telescope at Kitt Peak National Observatory in Arizona. The red reveals ionized hydrogen gas, blue denotes doubly ionized oxygen, and green shows visible light.

P. Massey (Lowell), N. King (STScI),
S. Holmes (Charleston), G. Jacoby (WIYN)/
AURA/NSF

View Over 15,000 Product Descriptions Online!

Order Online

www.focuscamera.com

TOLL FREE FAX: **800-TO-FOCUS**
OVERSEAS FAX: **718-437-8811**

800-221-0828

N.Y. STATE & OVERSEAS:
718-437-8810

MEADE ADVANCED PRODUCTS

MAKSUTOV-CASSEGRAINS ETX SCOPES

Exquisite, Diffraction-Limited Imaging in an advanced, ultra portable telescope system!

ETX-90EC Includes:
w/Dual-Axis Drive,
8x21 Erect-Image Viewfinder
& 26mm Plossl

ETX- 125EC Includes:
Dual-Axis Drive,
8x25 Right-Angle Viewfinder
& 26mm Plossl

Optional #497 Autostar controller with GO TO capability $99

ETX 70 AT 70mm (2.8") 350mm f/5 w/tripod	$349
ETX 90EC 1250mm f/13.8	$494
ETX 90EC 1250mm f/13.8 w/UHTC	$545
ETX 105EC	$695
ETX 105EC w/UHTC	$799
ETX 125EC 1900mm f/15	$895
ETX 125EC 1900mm f/15 w/UHTC	$990
#883 Deluxe ETX Field Tripod (90/105/125)	179
#884 Deluxe ETX Field Tripod (90/105/125) w/carrying bag	199
#64 Photo Adapter f/ETX (90/125)	34.95
#825 8x25 Right-Angle Viewfinder (90)	49.95
#880/#881 Equatorial Table Tripod (90/125)	29.95/59.95
#932 45° Erecting Prism (90/125)	49.95
#1244/#1247 Electric Focuser (90/125)	119.95
#773, #774, #775 ,#776 Hard Case for ETX	CALL

PICTOR CCD IMAGERS 416-XTE & 1616-XTE

With New Kodak Blue-sensitive CCD Chip

For the beginner, or for the most advanced observer, the real CCD revolution is here!

201-XT Autoguider/Imager	395
208-XT Autoguider/Imager	495
216-XT Autoguider/Imager	695
416-XTE Autoguider/Imager	1,995
1616-XTE Autoguider/Imager	6,495
Off Axis Guider f/CCD	89.95
616 Color Filter System f/416, 1616-XT	695
616A Color Filter System f/216	695
520 Electronic Relay f/201, 208, 216, 416, 1616	94.95
541 AC Adapter f/201, 208, 216	36.95
542 AC Adapter f/416, 1616	94.95

EYEPIECES

MODIFIED APOCHROMATIC

9, 12, 25, 40mm 1.25"	37.95	9, 12, 25, 40mm .96"	29.95

PLOSSL SERIES 3000

5, 6.7, 9.5, 16, 25mm 1.25"	49.95	40mm 1.25"	79.95

SUPER PLOSSL SERIES 4000

6.4, 9.7, 12.4, 15, 20, 26mm 1.25"			79.95
32, 40mm 1.25"	99.95	56mm 2"	199.95

PLOSSL SERIES 4000 SUPER WIDE ANGLE

13.8mm 1.25"	139.95	18mm 1.25"	149.95
24.5mm 1.25"	179.95	40mm 2"	299.95
32mm 2"			239.95

PLOSSL SERIES 4000 ULTRA WIDE ANGLE

4.7mm 1.25"	169.95	8.8mm 1.25"/2"	239.95
6.7mm 1.25"	199.95	14mm 1.25"/2"	299.95

ILLUMINATED RETICLE EYEPIECE SYSTEMS

	Wireless	w/Cord
Plossl 9mm 1.25"	149.95	129.95
MA 12mm 1.25"	99.95	79.95
MA 12mm Astrometric 1.25"		119.95
Plossl 25mm CCD Framing Ocular 1.25"		129.95

BARLOWS

#122 2x Telenegative 1.25"	44.95
#126 2x Short Focus 1.25"	44.95
#127 2x-3x Variable 1.25"	56.95
#134 Achromatic .96"	44.95
#140 2x Apochromatic 1.25"	74.95

SCHMIDT-CASSEGRAINS

The Meade LX200GPS, the most important advanced Schmidt-Cassegrain technology in 10- years, is here!

Standard-equipment includes:
- 16-channel GPS receiver
- GO TO pointing position
- LX-200 High-Precision Pointing mode
- Zero image-shift micro-focuser
- 40-hour internal battery
- Magnetic declination compensation
- Auto-Star II hand controller accesses 125,000 object database

LX-90 8" f/10	$1,695
LX-90 8" f/10 w/UHTC	$1,870
LX-10 8" w/wedge & tripod	$995
LXD 300 SERIES 203 8" f/10	$795
LXD 500 SERIES 203 8" f/10	$895
LX-200 GPS 7" Maksutov-Cassegrain	$2,995
LX-200 GPS 7" Maksutov-Cassegrain, w/UHTC	$3,145
LX-200 GPS 8"	$2,495
LX-200 GPS 8" w/UHTC	$2,670
LX-200 GPS 10"	$2,995
LX-200 GPS 10" w/UHTC	$3,230
LX-200 GPS 12"	$3,495
LX-200 GPS 12" w/UHTC	$3,790
LX-200 GPS 14"	$4,295
LX-200 GPS 14" w/UHTC	$4,695
LX-200 GPS 16"	CALL

ED APO REFRACTORS

300 SERIES

102 Achromatic 4" f/9	$549

500 SERIES

102 Apochromatic 4" f/9	$1,599

102ED 4" f/9 w/Mount, Tripod & Acc.	$2,795
127ED 5" f/9 w/Mount, Tripod & Acc.	$3,295
152ED 6" f/9 w/Mount, Tripod & Acc.	$4,995
178ED 7" f/9 w/Mount, Tripod & Acc.	$5,995

Optical Tube Only	CALL
#1207 Electric Focuser	144.95
#1664 Electronic Drive	349
#1697 Computer Drive System	749
#1702 Dual Axis Drive System	195
#1812 Electronic DC Adapter	89.95

ACCESSORIES

#62 T-Adapter f/SCT	26.95	Off Axis Guider	79.95
#931 45° Hybrid Erct Prsm	43	f/6.3 Focal Reducer	129.95
Basic Tele-Extender	29.95	**#1205** Focuser	CALL
Camera Adapter 1.25"	29.95	**#1206** Focuser	CALL
Camera Adapter .96"	27.95	6x30 Viewfinder	CALL
Variable Tele-Extender	39.95	8x50 Viewfinder	CALL
DEW SHIELD & DUST COVER	Call	**#607** 25' Cigarette Adpt	25
Piggyback Bracket f/SCT	Call	55 Manual DEC Control	75

Variable Projection Camera Adapter 1.25"	39.95
#927 45° Erect Image Diagonal Prism .96"	42.95
#928 45° Erect Image Diagonal Prism 1.25"	42.95
#929, #930 2" Mirror Diag. w/Eyepiece Holder f/1.25"	99.95
Tube Balance Weight System f/All SCT	CALL
#531 Motor Drive w/Auto Tracking f/4500 Newtonian	CALL
Interface Cable f/LX-200	25
EPOCH 2000sk Sky Software 3.5" Disks	149
EPOCH 2000sk Sky Software CD	179
EPOCH 2000ip Software 3.5" Disks	199

FILTERS

#905 Variable Polarizer 1.25"			49.95
Moon Filter ND96 1.25"	19.95	4 Piece Set 1.25"	49.95
Individual Filters	14.95	Skylight/Dust Seal	44.95

* Nebular	Oxygen III	Broadband*	Narrowband*
#908 1.25"	99.95	79.95	89.95
#910 2"	159.95	119.95	129.95
#911 Rear Cell	149.95	99.95	119.95

LXD55

Now you can buy a Schmidt-Newtonian telescope with Autostar dual-axis GO TO drive system for $695

Featuring:
- **6 x 30mm achromatic viewfinder**
- **All metal rack & pinion focuser**
- **German-type mount w/worm-gear drives**
- **Electric slow-motion controls**
- **9-speed drive controls**
- **30,223 object software library**

5" Achromatic Refractor w/Elect. Controller	$579
5" Achromatic Refractor w/Autostar	$695
6" Achromatic Refractor w/Autostar	$895
6" Schmidt-Newtonian w/Elect. Controller	$579
6" Schmidt-Newtonian w/EC & UHTC	$664
8" Schmidt-Newtonian w/Elect. Controller	$699
8" Schmidt-Newtonian w/EC & UHTC	$824
6" Schmidt-Newtonian w/Autostar	$695
6" Schmidt-Newtonian w/Autostar & UHTC	$780
8" Schmidt-Newtonian w/Autostar	$839
8" Schmidt-Newtonian w/Autostar & UHTC	$964
10" Schmidt-Newtonian w/Autostar	$995
10" Schmidt-Newtonian w/Autostar & UHTC	$1,145
8" Schmidt-Cassegrain w/Autostar	$1,195
8" Schmidt-Cassegrain w/Autostar & UHTC	$1,370

DIGITAL ELECTRONIC SERIES

Because of their sophisitcated "AutoStar" software package and a finely engineered "AutoStar" controller, these scopes surpass all the competition!

- Object tracking • *Autostar* computer controller
- Electronic controller • Altazimuth mountings
- Meade StarNavigator software

REFLECTOR DS-2114Ats / 4.5" f/8.8	$349
REFLECTOR DS-2130Ats / 5" f/8.8	CALL
REFRACTOR DS-2070At / 2.8" f/10	$299

SPECIALS

HARBORMASTER TELESCOPE

(#683576)

- **Individually Numbered** • **Hand Finished Legs**
- **Brass Tube** $1799.95

Meade 8x22 CaptureView Intergrated Binoculars and Digital Camera . . . $99

BINOCULARS & SPOTTING SCOPES

CELESTRON

BINOCULAR BLOWOUTS!

20x80 Giant Deluxe . . $429.95

10x25 Watersport	69.95	8x25 Enduro Mini	34.95
10x50 Regal	334.95	8x32 WA Ultima	188.95
10x50 Ultima	839.95	8x40 Ultima	199.95

MEADE

8x25 Safari Pro	109	10x25 Safari Pro	129
7x36 WA Safari Pro	170	8x42 WA Safari Pro	180
10x42 Safari Pro	129	10x50 WA Safari Pro	199
7x42 WA Rainforest Pro	399	8x56 Rainforest Pro	479

Nikon SPORT OPTICS

You'll Never See Things Quite The Same Again!

8x30 E 257 / 10x35 E 299		10x70	1048.95
8x32 E Superior	CALL	7x50 Prostar	721.95
10x42 E Superior	CALL	10x40 Lookout IV	102.50
12x50 E Superior	CALL	10-22x50 Scoutmaster XL	135

SPOTTING SCOPES

Fieldscope (60mm)			347.95
Fieldscope 60 II	574.95	60 II Angled	634.95
Fieldscope 78 ED	1229.99	78 ED Angled	1299.99

Leica

SPOTTING SCOPES
APO TELEVID 77mm
Ask About Leica's Passport Protection

Kowa

77MM SERIES SPOTTING SCOPES

TSN-3	$799.95
TSN-4	$649.95

82MM SERIES WATERPROOF SPOTTING SCOPES

TSN-821M Angled	CALL
TSN-822M Straight	CALL
TSN-823M Angled	CALL
TSN-824M Straight	CALL

Check Out Our Special Package Pricing on 820 Series Spotting Scopes
Package includes: Scope, 20-60x, Case & Tripod

ZEISS

Special! 15x60	$1,799
8x40 Victory	979
10x40 Victory	999

Canon

IMAGE STABILIZERS
10x30 • 12x36
15x50 AW • 18x50 AW

FUJINON

16x70 FMT-SX w/Case	CALL
7x50 FMTRC-SX w/Comp	569
8x32 HS Rubber Armored	229
10x32 HS Rubber Armored	249

C90 Multicoated Spotter

CELESTRON

Several models still available, call for special

LOW PRICE!

BAUSCH & LOMB BUSHNELL

15-45x60 Long Eye Relief	(#781645)	135
15-45x Zoom w/tripod	(#781817)	280
15-45x60 Camouflage w/tripod	(#781217)	295
Multi-Position 15-45x50 Viewfinder	(#787350)	140
Multi-Position 20-60x60 Viewfinder	(#787360)	170
20-45x60 Long Eye Relief	(#781821)	289

STEINER

12x56 Night Hunter	CALL	20x80 Senator	989
15x80 Senator	969	8x42 Predator	CALL
10x42 Predator	CALL	12x40 Predator	389
8x32 Predator	589	10x30 Predator	389
12x30 Predator	389	8x22 Safari *Special*	99
7x50 Commander III	CALL	8x30 Navigator	CALL

Leica

Televid 77 Angled	795	Televid 77 Straight	795
APO Televid 77 Angled or Straight			1295
Ocular B 20-60x	329	12x50 BN	1245

ALL ORDERS ARE SUBJECT TO AVAILABILITY AND VERIFICATION. ORDERS ONLY CALL 888-221-0828 • INFORMATION & NY STATE CALL (718)437-8810 **Orders** ORDER STATUS & CUSTOMER SERVICE (718) 437-8899 • 24-HOUR FAX LINE (877) 863-6288• STORE INQUIRIES (718) 436-6262. Shipped Promptly - Most Major Credit cards, Money orders & personal checks accepted for payment. COD orders are accepted but may require a deposit, personal checks may require up to 14 days to clear. All orders are subject to verification & acceptance. Shipping, handling & insurance are additional,please call/write for exact details. 4-day money-back guarantee (less shipping) provided merchandise is returned in new condition, unused as received with papers & packaging intact. We gladly accept and reply to written or faxed inquiries. Ad prices available while supplies last. This ad supersedes all previous ads. Focus Camera is not responsible for typographical errors. Hours: Mon.-Thurs. 9-7, Fri. 9-2, Sun. 10-6.

America's Largest Stocking Authorized Astronomy Dealer!

800-221-0828

N.Y. STATE & OVERSEAS: **718-437-8810**
E-MAIL ADDRESS: **orders@focuscamera.com**
Order on the Web: **www.focuscamera.com**
We ship our orders promptly!

CELESTRON

SCHMIDT-CASSEGRAINS NexStar 8

Images in the NexStar 8 are over two times brighter than with a 5" telescope. With the touch of a button, the NexStar 8 will open door to planets, galaxies and nebulae that you have never experienced in your lifetime. Exquisite design, pinpoint computer control and stability come together in one dynamic package.

NexStar 11 GPS	$2,999
NexStar 8 GPS	2,499
NexStar 8 8", 2032mm f/10, **w/TRIPOD**	1,499
NexStar 8i 8"	1,199
NexStar 5 5", 1250mm f/10, **w/TRIPOD**	1,129
NexStar 5i 5"	899
NexStar 4 4"	599
NexStar 60 GT	249
NexStar 80 GT	349
NexStar 114 GT	439
G-5 5", 1250mm f/10	679
G-8N 8" Newtonian, 1000mm	699
G-9 1/4 9.25", 2350mm f/10	1,329

STARTER KIT #94301
- Night Vision Flashlight
- Moon Filter
- 2x Barlow Lens
- Car Battery Adapter
- Plastic case w/foam

$99

STARTER KIT #94302
- Night Vision Flashlight
- Car Battery Adapter
- Filter Set • Plossl 13&32mm
- Plastic case w/foam
- 2x Barlow Lens

$199

REFRACTORS

Firstscope 114
114mm (4.5")
$249

Firstscope 70 EQ
$179

Firstscope 114 Short
114mm (4.5")
$219

Firstscope 76 EQ
$159

Firstscope 60 AZ	$79
Firstscope 60 EQ	$139
Firstscope 80 AZ/EQ	$249/$299

C80-HD 80mm (3.1"), 900mm f/11	$349
C102-AZ 102mm (4"), 1000mm f/10	$389
C102-HD 102mm (4"), 1000mm f/10	$449
CR-150-HD 150mm (6"), 1200mm f/8	CALL

NEWTONIANS

C114-HD 114mm (4.5"), 900mm f/8	$329
C150-HD 150mm (6"), 1000mm f/7	$449

EYEPIECES & VIEWING ACCESSORIES

Diagonal, Prism Star	39.95	Diagonal, Mirror 2"	129.95
Diagonal, Erect Image 45°			39.95
Diagonal, Erect Image 90°			49.95
Tele-Extender Deluxe			48.95
Ocular NexStar Plossl 1.25", 3.6, 6, 8, 10, 13, 17, 25mm			48.95
Ocular NexStar Plossl 1.25", 32, 40mm			58.95
Ultima Series 1.25" 5, 7.5, 12.5, 18mm			74.95
Ultima Series 1.25" 35mm			104
LV Series 1.25" 5, 6, 9, 10, 15mm			109.95
LV Series 1.25" 8-24mm Zoom			159.95
Ocular Oxiom 1.25" 15mm			149.95
Ocular Oxiom 1.25" 19mm			159.95
Ocular Oxiom 1.25" 23mm			169.95
BARLOWS			
2x 1.25"	39.95	2x 1.25 Ultima	62.95

FILTERS

4-Piece Filter Sets	49.95	Skylight Filter	44.95
Moon Filter 1.25"	19.95	Solar Filters	CALL
LPR Filter Model A 1.25"			59.95
LPR Filter Model B f/Back Threads of SC's			84.95
Polarizing Filter Set 1.25"			42.95

SCHMIDT-CASSEGRAINS CELESTAR 8 COMPUTERIZED

Engineered for unsurpassed optical performance in an affordable, full featured Schmidt-Cassegrain telescope of large enough aperture to do serious deep-sky observing. This telescope is carefully crafted and manufactured in the USA for dependable quality of the highest caliber. It offers the lowest price ever for a Celestron fork mounted 8" telescope.

CELESTAR 8 8", 2032mm f/10	$1,099
CELESTAR 8 Computerized	$1,434
CELESTAR 8 Deluxe	$1,699
CELESTAR 8 DLX Computerized	$1,989
ULTIMA 2000 8" 2032mm f/10	$2,699
CM-1100 11", 2800mm f/10	$3,199
CM-1400 14", 3910mm f/11 **(IN STOCK!)**	$5,299
CM 1400 GT 14"	$6,199

SPOTTING SCOPES

C5 Spotter

- Fully multicoated optics
- Excellent light gathering ability
- Standard 8x20 erect image finderscope
- Near focus of 20'
- 45° erect image diagonal & 26mm Plossl 48x eyepiece – both 1.25"
- 22mm eye relief and 1° field of view with standard eyepiece
- Fitted with convenient tripod adapter block

$549

80mm Wide View	$199
50mm Zoom	$99
60mm Zoom	$69
30mm Mini Spotter	$49

TRIPODS & MOUNTS

Heavy Duty Tripod (93499)	284.95
Photographic Tripod (93596)	99.95
Standard 8" Wedge (93656)	92.95
Heavy Duty Wedge (93655)	239.95
Upgrade Kit f/93655	109.95
Equatorial Mount CG-3	144.95
Equatorial Mount CG-5	369.95
CI-700 Mount	1,859.95
Vibration Suppression Pads	39.95

ACCESSORIES

AC Adapter	18.95	Lens Shades	CALL
Focus Motor	114.95	Motor Drives	CALL
Car Battery Adapter	18.95	T-Adapter f/C90	28.50
Radial Guider	97.95	T-Adapter f/SCT's	24.95
Case f/C5 & C8 (Most Models)			209.95
Counterweight Bar Assembly 8"			89.95
Counterweight Bar Assembly 11"			94.95
DEC Motor f/C5+, Celestar 8, Ultima 9 1/4/11			CALL
Digital Setting Circles			299.95
Flashlight Red Astro Lite			9.95
Flashlight, Night Vision			21.95
Focus Micrometer, Digital			109.95
Hand Controller f/C5+, Celestar 8			49.95
Piggyback Mount 8"			34.95
Reducer/Corrector f/6.3			111.95

FINDERSCOPES

5x24	23.50	7x50 w/Illuminator	159.95
6x30	39.95	9x50	44.95

TELRAD
Finder Scope $\$36^{49}$

TeleVue Visionary

TeleVue 102 APO
4" 880mm, f/8.6 .... **$2,635**
Available in Black, Ivory or Solid Brass

TV-85
85mm, 600mm f/7
Green or Ivory

TeleVue NP101
4" 540mm, f/5.4 .... **$3,385**
Available in Ivory only

Pronto™

70mm ED, 480mm f/6.8
Available in Ivory or Green

O.T.A.	$775
Pronto Package	$1220

Ranger

70mm ED, 480mm f/6.8
Available in Evergreen & Brass

O.T.A.	$570
Ranger Package	$695

MOUNTS

TELE-POD MOUNT SYSTEM
Complete 7lbs Mounting System Ideal for Traveling ... **$365**

Ash Panoramic Mount	$495
Ash Gibraltar Mount	$530
Ash Gibraltar w/Sky Tour	$1,300

EYEPIECES

ZOOM EYEPIECE 8-24mm	$210
NAGLER ZOOM EYEPIECE 3-6mm	$380

PLOSSL (50°)		**PANOPTIC (68°)**	
8, 11mm 1.25"	82	15mm 1.25"	210
15mm 1.25"	82	19mm 1.25"	240
20, 25mm 1.25"	95	22mm 2"/1.25"	280
32mm 1.25"	110	27mm 2"	330
40mm 1.25"	110	35mm 2"	365
55mm 2"	228	Barlow Interface	90
RADIAN (60°)		**NAGLER (82°)**	
3, 4, 5, 6mm 1.25"	240	4.8mm 1.25"	155
8, 10,12mm 1.25	240	7mm 1.25"	190
14, 18mm 1.25"	240	9mm 2"/1.25"	240
NAGLER Type 5 (82°)		**NAGLER Type 2 (82°)**	
16mm 1.25"	320	16mm 2"/1.25"	310
31mm 2.25"	620	**NAGLER Type 4 (82°)**	
NAGLER Type 6		12mm 2"/1.25"	355
5, 7.mm 1.25"	280	17mm 2"	385
9mm 1.25"	280	22mm 2"	460
BARLOWS			
2x 1.25"	105	2.5x Powermate	168
2x Big 2"	168	4x Powermate	265
3x 1.25"	105	5x Powermate	168

ACCESSORIES

RICH FIELD KIT Includes: 2" Star Diagonal, SCT to 2" E.P. Adapter & 2" to 1.25" E.P. Adapter			300
RICH FIELD PREMIUM KIT w/Everbright 2" Star Diag.			365
Bino Vue Binocular Viewer			1,030
Paracorr Photo/Visual 2" Coma Corrector			295
Everbright 2" Star Diagonal Mirror			255
2" Enhanced Star Diagonal			190
1.25" Star Diagonal			75
1.25" Prism 45°	60	Air Chair	175
Basic Qwik Point (QPU)			19
Starbeam Projection Finder			180
Camera Adapter 1.25" & 2"	45	Piggy-Cam Camera Adapter	42

Digital Camera to Radian Adapters

DRA-0028	$55
DRA-0037	$55
DRA-0049	$55

ASTRONOMY BOOKS

The Deep Sky: An Introduction

By Philip S. Harrington Here is the perfect reference for anyone, who owns a telescope or a pair of binoculars but doesn't know what to look for amid the constellations. It explains how to find double and multiple stars, variable stars, open and gobular clusters, nebulae, and galaxies — what you'll see when you do.Includes 36 full-page sky charts; equipment, books, and software suggestions; sketches of how deep-sky objects look through a small telescope; and more than 100 black & white photographs. 272 pages.

The Deep Sky: An Introduction			24.95
Backyard Astronomer's Guide			39.95
Nightwatch: A Practical Guide to Viewing the Universe, 3rd Edition			29.95
Star-Hopping for Backyard Astronomers			19.95
Celestron Sky Map			16.95
Meade Star Chart			16.95
Sky Altas 2002			
Deluxe Edition			49.95
Desk Edition	27.95	Field Edition	27.95
Laminated Deluxe Edition			99.95
Laminated Desk Edition			59.95
Laminated Field Edition			59.95

JMI JIM'S MOBILE INC.

Next Generation Computers
Motofocus • NGF Focuser
Wheely Bars • Motodec

THOUSAND OAKS

Precision Glass Solar Filters
Mounted Type 2
Mounted Type 2 Plus
Mounted Type 3 Plus

Space.com Software

Starry Night Beginner CD f/Win/Mac	$\$29^{95}$
Starry Night Backyard CD f/Win/Mac	$\$49^{95}$
Starry Night Backyard SE CD f/Win/Mac	$\$59^{95}$
Deep Space Explorer CD f/Win/Mac	$\$49^{95}$
Starry Night Pro CD f/Win/Mac	$\$129^{95}$

Take advantage of our *LARGE INVENTORY!* Immediate shipment from stock!

Focus Camera, Inc., 4419-21 13th Avenue, Brooklyn, New York 11219

A Dust-Free Universe?

I appreciate your in-depth articles on cosmology, but was disappointed with what seems to be an inadequate explanation of the effect of dust on the supernova observations ("Moving Right Along," July).

The explanation given by author Mario Livio seems to be based on the supposition that the light from Supernova 1997ff was passing through the same density of dust during the earlier part of its journey to us as it was during the latter part. As I understand it, the early universe could not have had dust, as dust is made up of elements not present until some of the first generation stars had completed their life cycles. It would then have taken considerable time for these elements to form particles large enough to absorb light, and to be distributed so evenly through intergalactic space that the brightness of a single supernova would be significant.

Dust in the immediate vicinity of the supernova would also be significant, and I believe this would depend on the state of evolution of the parent galaxy. In a younger galaxy, a supernova would be more likely to be found near the dusty center of the galaxy, but a very young galaxy would have little dust for reasons already given. — *Peter Henderson, George, South Africa*

The process of dust formation is indeed quite complex, and it does require, as you point out, the existence of "metals," which were not present in the very early universe. The dimming depends on the type of dust present (in terms of distribution of grain sizes). Astronomers have examined the possibility of dust obscuration for the distant supernovae in great detail. In the article, I merely pointed out that the effects of dimming by dust are expected to be cumulative (not homogeneous). The scientific paper mentioned in the article proves that the observations of SN 1997ff are inconsistent with dust obscuration. — Mario Livio, Space Telescope Science Institute, Baltimore

Did dust from galaxies such as the Sombrero Galaxy (M104) have an effect on supernovae in the developing universe? Ralph Sargent

Determining Distance

I enjoyed Livio's article, but I found some of the information confusing. He says astronomers use Type Ia supernovae to determine distance. Then he says supernovae "with redshifts of 0.5 and higher appeared some 0.3 magnitude dimmer than expected at their distances." But I thought it was magnitude that revealed a star's distance; I would have expected the author to say those supernovae with redshifts of 0.5 and higher appeared more distant than expected. — *Bruce McClure, Norwood, New York*

The phrase I used referred to the distance as implied by a straight Hubble Law, but that may have been somewhat ambiguous. The meaning was indeed that the supernovae were more distant than expected. — M. L.

Is it a Full Moon?

I enjoyed reading Bob Berman's "Bad Moon Rising" (September). As the director of a planetarium, I am often asked whether the Full Moon affects things such as birthrates or the number of arrests. I often refer to the same studies as Berman. But I decided to do my own research by polling local hospitals and police stations. I came to the same conclusion as Berman — people don't notice when nothing unusual happens during a Full Moon, only if anything strange does happen. And frequently, circumstances are falsely attributed to the Moon phase. For example, if an unusual number of deliveries occurs on a particular day and someone in the hospital says, "It must be a Full Moon," people may assume that is true, even if it is not a Full Moon.
— *Wayne Wyrick, Kirkpatrick Planetarium, Oklahoma City*

Correction

The essay on page 53 of the October issue, "An Archaeoastronomer's Tour of Mayan Country," was mistakenly credited to Patricia Kurtz; it was written by Bonnie Gordon.

Astronomy *invites you to talk back. Send letters to* Astronomy *Talking Back, P.O. Box 1612, Waukesha, WI 53187; e-mail to talking@astronomy.com. Letters may be edited for space and clarity. Please include your city, state, and country. Visit our website at http://www.astronomy.com.*

Astronomy®

KALMBACH PUBLISHING CO.

PRESIDENT
Gerald B. Boettcher

VICE PRESIDENT, EDITORIAL, PUBLISHER
James J. Slocum

VICE PRESIDENT, MARKETING
Michael R. Stephens

VICE PRESIDENT, ADVERTISING
Scott Stollberg

CORPORATE ART DIRECTOR
Maureen M. Schimmel

MANAGING ART DIRECTOR
Lisa A. Zehner

PRODUCTION MANAGER
Annette Wall

CIRCULATION DIRECTOR
Jerry Burstein

CIRCULATION SPECIALIST
Kirsten King

CIRCULATION COORDINATOR
Kelly Ivan

ADVERTISING DEPARTMENT
(888) 558-1544

ADVERTISING SERVICES MANAGER
Sara Malin Everts severts@kalmbach.com

ADVERTISING SALES MANAGER
Dan Koehler dkoehler@astronomy.com

ADVERTISING SALES REPRESENTATIVE
Ken Kozerski kkozerski@astronomy.com

AD SERVICES REPRESENTATIVE
Maria De Grave mdegrave@kalmbach.com

RETAIL TRADE ORDERS AND INQUIRIES:
(800) 558-1544, ext. 818; outside the U.S. and Canada: (262) 796-8776, ext. 818

SPECIAL E-MAIL ADDRESSES

Ask Astro askastro@astronomy.com

Hot Shots hotshots@astronomy.com

Star Stuff starstuff@astronomy.com

Talking Back talking@astronomy.com

Customer Service customerservice@kalmbach.com

Ad Sales adsales@astronomy.com

Experience, Service & Selection... Not Alien Concepts at OPT!

Meade LX200 GPS "A New World Standard"
Meade Authorized Dealer
"The most important advance in Schmidt-Cassegrain technology in 10 years is here."
$99.00 Eyepiece Offer Hurry! exp 11-30-02

SBIG ASTRONOMICAL INSTRUMENTS
If CCD Cameras is the question... SBIG is the answer.

CELESTRON®
NexStar Technology
Brings the joy of astronomy home to you with affordable telescopes for all levels of enthusiasm
$99.00 Eyepiece Special! exp 12-31-02

TeleVue® Visionary
Don't settle for less... Half your Viewing quality depends on your eyepiece.

Takahashi
World Class Refractors... Now World Class "Go To" Mounts.

JMI
Hard sided, foam lined cases... because your scope needs a home!

OPT
OCEANSIDE PHOTO & TELESCOPE

800-338-9638
Open 7 days a week, (Mon-Sat 10a-8p) • We don't just sell equipment, we use it too! *You can order anything and everything you need on line.*
www.optcorp.com

Winter Telescope Sale & Demo
***Sat. Nov 9**, 10am-10pm Meet the Reps from Celestron & Discovery.*
***Sat. Nov 16**, 10am-10pm Meet the Reps from Meade, Televue & SBIG.*

1024 Mission Avenue, Oceanside, CA 92054

Anyone can sell you a telescope.

Authorized Meade Dealer

Meade ETX-90EC
$495 ($545 w/UHTC)
Meade ETX-105EC
$695 ($770 w/UHTC)
Meade ETX-125EC
$895 ($990 w/UHTC)
#497 Autostar **$149**

Hardly a day goes by that we don't get a note or e-mail message like the one reprinted on the next page, or a call that goes something like this: "Your ads are right. Dealer so and so advertises low prices – but they don't have what I want in stock, they couldn't answer *any* of my questions, and they wanted my credit card number before they'd even *talk* to me. They said if I wanted to ask questions, I should call the manufacturer . . . and then they hung up on me!"

If you want the right telescope, you need more than a camera store clerk armed with only a price list and a puzzled look when you ask questions.

What you *really* need are people who take the time to listen to what *you* need, people who answer your questions truthfully, people with years of experience using and selling telescopes who can help you get the most telescope for your dollar. That's exactly the kind of people you'll find at ***astronomics***. We have a combined total of 160 years of experience using and selling scopes!

Unlike camera stores and shopping mall gift shops, telescopes are our specialty at ***astronomics***, not just a sideline. We're a family-owned full-line telescope dealer – not just a few toy telescopes stuck off in the corner of some no-help department store, toy store, or gift shop as an afterthought. And, unlike department store clerks, we don't work on commission, so we won't try to sell you more than you need just to pad our paychecks.

We've been helping people choose the right telescope since 1979. We have the experience to help *you* pick the scope that fits your needs . . . *and your budget* . . . from the hundreds of Celestron, Discovery, Meade, Questar, Stellarvue, Takahashi, TeleVue, TMB, and Vixen scopes we stock. And with our large inventory, we can usually ship you the right scope right away.

astronomics. No hard sell. No guesswork. Just honest advice, the *right* scope, and a good price. Call us at (405) 364-0858 and find out for yourself.

"Optics as good as I have seen . . . in any telescope . . . at any price."

A review in June's *Sky & Telescope* said the **TMB 100** 4" f/8 ED triplet apochromatic refractor had "optics as good as I have seen in any refractor, indeed in any telescope I've tested or used at any price." It just confirms what dozens of our very satisfied customers have been saying about their TMB apo refractors for months.

Not only do the TMB ED apo refractors have optically unsurpassed triplet optics and precision mechanics (such as a 3" focuser), but many of the sizes listed below are available from stock. Even those that may be temporarily out of stock are usually available again in few short months, not a few years, as is the case with another well-known brand.

Why wait years for another triplet apo when you can be observing with the best right now? For more details and pictures, visit our website to see the apo refractors that are the talk of experienced astronomers everywhere.

TMB 80/6	80mm (3.1") f/6	\$1690^{00}
TMB 80/7	80mm (3.1") f/7	1690^{00}
TMB 100	100mm (4") f/8	3290^{00}
TMB 105	105mm (4.1") f/6.2	3290^{00}
TMB 152	152mm (6") f/7.9	6990^{00}
TMB 175	175mm (7") f/8	11,990^{00}
TMB 203	203mm (8") f/9	19,990^{00}
TMB 254	254mm (10") f/9	39,995^{00}

Custom-built Dobs.

Astronomics offers custom-made truss tube Dobsonians hand-crafted by Pete Kron, a long-time Astronomics customer who is now a full-time member of our staff. Pete has been custom-building Dobs for over 15 years, in sizes up to a 36" f/5, and is known for using premium quality components. While Pete specializes in 18" through 24" apertures, custom mirror sizes and focal ratios are also available. He can also upgrade your bulky and unwieldy commercially-made Sonotube Dobsonian to an easily transportable truss tube version.

Prices start at \$3500 for a custom-built 18" scope. Converting your commercially-made Sonotube Dob optics to a truss tube mount starts at \$1500 for a 16" f/4.5 scope.

For more information, or to discuss specific pricing, contact Pete via e-mail care of questions@astronomics.com. You can also reach him by phone toll-free from 9 to 5 Monday through Friday at (800) 422-7876.

The new Meade LXD55 EC scopes . . . add go-to when you need to.

Meade
5" AR-5EC
refractor
$579

Some observers enjoy hunting for celestial objects the way the pioneering astronomers did – by eye, star hopping from object to object. Others want a go-to scope to do the hunting for them, but have a budget that says, "Can't afford a go-to yet." For both groups, the Meade LXD55 EC scopes are the answer!

The 5" EC multicoated achromatic refractor and fast focal ratio Schmidt-Newtonian 6" and 8" reflectors (with either standard or optional UHTC optics) are complete working scopes, with standard dual-axis DC drives and four-speed/four direction EC hand control (which are costly options with competitive scopes). You can star hop or use setting circles to find objects. Once found, the scope tracks those objects automatically while you observe.

For the purist or the observer on a budget, they're all the scope you need now. *But* . . . just add an optional Autostar computer later and you have a fully computerized go-to telescope with 30,000 stars and objects in its memory. You can have as much or as little automation as you want, at a price you can afford *now!*

$729
Meade
8" SN-8EC
f/4 reflector
($854 w/UHTC)

Want the latest TeleVue telescope or eyepiece? We keep them all in stock.

Whether it's the newest telescope or the newest eyepiece (like the 3mm to 6mm Nagler zoom at \$380), if it's from TeleVue, chances are good we have it in stock. Gibraltar, Panoramic, and TelePod mounts; Nagler, Radian, Panoptic, and Plössl eyepieces; Powermates and Barlows; Everbrite diagonals; and more – we have it all. Others say they carry TeleVue, but we actually keep it stock. Call us and see.

All packages come without a mount, but with an eyepiece, star diagonal, tube ring for mounting, and case. Basic optical tubes, without accessories, are also available.

NP-101 **$3595**

TV-85 **$2080**

NP-101, package, without mount	\$3595^{00}
TV-102, package, without mount	2635^{00}
TV-102, optical tube only	2200^{00}
TV-85, package, without mount	2080^{00}
TV-85, optical tube only	1680^{00}
TV-76, package, without mount	1675^{00}
TV-76, optical tube only	1275^{00}
Pronto, package, without mount	1120^{00}
Pronto, optical tube only	775^{00}

We carry Vixen. Great performance, sane prices.

For many years, the Vixen scopes from Japan have been European best-sellers. For years, they were also sold in the States by a famous U. S. manufacturer under that manufacturer's own name. They gained that manufacturer a reputation for optical and mechanical quality, but you could rarely buy Vixen scopes under the Vixen name at reasonable prices. Now they're finally available in the U. S. under the Vixen name by which they're known worldwide – and at sane prices. The importer is TeleVue, a company with a sterling repuation for quality of its own.

Whether it's a telescope, mount, or accessory, if it's from Vixen, chances are good we have it in stock. Lanthanum long eye relief and wide angle long eye relief eyepieces; Great Polaris and Great Polaris DX mounts; ED, Fluorite, and dual ED doublet apochromatic optical tubes and complete scopes; photo accessories; and more – we have it all. Visit our website for a complete listing of available stock or call us and see for yourself.

Vixen

$2200

Vixen GP ED102S
4" f/9 ED apochromatic refractor
(with optional motor drive)

A \$450 bino for \$179^{95}? One couple bought 9!

One couple liked the \$450 list **Celestron Tasco 8 x 42mm Rare Bird** roof prism binoculars they bought from us so much that they bought seven more to give to their kids and their spouses!

Armored, waterproof, multicoated, with BaK4 prisms, a soft case, wide neck strap, 6.6° field, and long 16mm eye relief. The Rare Bird is great for astronomy, wildlife observation, or just all around family fun. It has a lifetime no-fault warranty, too!

Free $7.95 Nikon lens cleaning pen with purchase

Over 1,000,000 people a year visit our website for reliable info, helpful features, and secure on-line shopping.

www.astronomics.com

Our 5 brands of light pollution filters bring dark skies to a light-polluted world.

If city lights are blocking your view of the heavens, get rid of the light pollution with one of the many nebula filters we stock.

We carry the **Celestron** broadband filter in both 1.25" and SCT rear cell versions.

We carry the **Lumicon** Deep Sky, UHC, Oxygen III, and H-Beta filters in 1.25", 2", and rear cell versions for SCT use. We also have two-filter Lumicon sets in various combinations at money-saving package prices.

We carry the **Meade** broadband, narrowband, and Oxygen III filters in 1.25" and rear cell versions for SCT use.

We carry the **Sirius** 1.25" and 2" broadband and nebula contrast enhancement filters.

Last but not least, we carry the **Thousand Oaks** broadband, narrowband, Oxygen III, and H-Beta filters in 1.25" and 2" versions.

Our free catalog helps you pick the right Celestron, Meade, Questar, Stellarvue, Takahashi, TeleVue, TMB, or Vixen scope.

For detailed information on individual products, visit our Web site. You can call us at (405) 364-0858, or e-mail us, for your *free* copy of our catalog AST. It covers all the scopes and accessories we stock – from Bushnell, Canon, Celestron, Coronado, Discovery Telescopes, JMI, Losmandy, Lumicon, Meade, Nikon, Parallax Instruments, Pentax, Questar, Rigel Systems, SBIG, Software Bisque, Stellarvue, Takahashi, TeleVue, TMB, Vixen, and more. We'll include our guide on how to pick the right scope and your discount prices on the 1000+ products we carry. (Sorry, U. S. sales only.) The catalog is yours for only the cost of a one minute phone call. The information we send will make it the most useful minute you'll ever invest in astronomy.

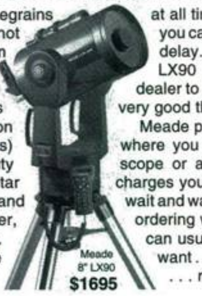
astronomics

Our 24th year of friendly service, good advice, and money-saving prices.

680 SW 24th Avenue, Norman, OK 73069
Toll-Free Order Line: **(800) 422-7876** Catalogs/Questions/Advice: **(405) 364-0858**

We'll sell you the *right* telescope.

Why wait? We'll ship either Meade LX90 from stock.


Meade 8" LX90 **$1695**

The 8" **Meade LX90** Schmidt-Cassegrains let you enjoy 8" go-to astronomy for not a lot of money. They're available from stock with either standard optics or the new optional UHTC optics.

The LX90 with standard optics is only $1695. The UHTC optics version LX90 (with up to 20% brighter images) is only $1870. Both have a heavy-duty adjustable height tripod, an Autostar go-to computer with a 30,223 star and object data base, a big 8 x 50mm finder, and a 26mm Super Plössl eyepiece.

We usually have a dozen or more of both versions of the LX90 in stock at all times, so the chances are good you can get *your* LX90 with little or no delay. If Meade is shipping either LX90 *(or any Meade scope)* for a dealer to keep in stock, the chances are very good that we *have* it in stock.

Meade prices are about the same anywhere you call. So why order a Meade scope or accessory from a dealer who charges your credit card, then makes you wait and wait until he finally gets around to ordering what you want? Not when you can usually get the Meade scope you want . . . right now . . . at the right price . . . right here at ***astronomics***.

8" and 10" Meade GPS UHTC scopes ship from stock. They do all the work so you can see 20% more.

Meade 8" LX200 GPS with UHTC

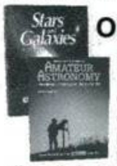
$2670

Never before have so many features been packed into one telescope series. The LX200GPS scopes – the widest variety of premium go-to telescopes on Earth – have all the features you've dreamed about since you started astronomy – plus optional UHTC (Ultra High Transmission Coatings) for up to 20% brighter images.

You get fully automatic GPS alignment with true north and true level sensors and automatic magnetic declination correction; a unique mirror lock to eliminate image shift during critical CCD imaging; a standard equipment 4-speed electric focuser; a built-in computer database of over 145,000 stars and objects; flashlight battery operation; and much more.

Meade GPS scopes with UHTC optics will let you see up to 20% *more.* Plus, you'll spend more time looking *at* celestial objects and less time looking *for* them. We had 36 8" and 10" LX200GPS scopes with UHTC in stock as this was written. Chances are good we have one in stock for you.

Observing books up to 50% off!



We bought almost 4000 deep space observing books at very special prices. We're passing our savings on to you, pricing them as low as 50% off retail. Just take a look and save . . .

Beginner's Guide to Amateur Astronomy 166 page soft cover, a great way to start, reg. $14.95	**$9⁹⁵**
Galaxies & The Universe 112 page soft cover, helps you find 100s of galaxies, reg. $19.95	**$9⁹⁵**
Stars & Galaxies 200 page hard cover, observe 344 of the best deep sky objects, reg. $29.95	**$14⁹⁵**
Universe From Your Backyard 188 page hard cover, observe 690 deep sky objects, reg. $29.95	**$14⁹⁵**

Canon image-stabilized binoculars . . . a whole lot less shaking going on!

"Truly a quantum leap in binocular observing . . . particularly impressive was how well these binoculars compared to much larger apertures . . ." is what *Sky & Telescope* said about the Canon image-stabilized binoculars. There are no jittery images while hand-holding these binos, just rock-solid observing that reveals more detail than conventional binoculars. From a compact 8 x 25mm handy for travel and birding to a big 18 x 50mm that's excellent for astronomy, there's an image-stabilized Canon binocular that's right for you – and at a new lower price from Canon. You'll find full details on our website.

Get $700 worth of Celestron accessories for $99!

Through December 31, buy *any* Celestron telescope, and we'll send you $700 worth of Celestron eyepieces and filters for only $99! You'll get fully multicoated 1.25" Plössl eyepieces in focal lengths of 4, 6, 9, 15, and 32mm; a fully multicoated 1.25" 2x Barlow; a 1.25" neutral density Moon filter; #12 medium yellow, #21 orange, #25A medium red, #56 light green, #58A dark green, and #80A medium blue 1.25" eyepiece color filters; and an aluminum case to hold them – for only $99!

The full details of this sensational Celestron limited time $99 offer can be found on our website at **www.astronomics.com**.

Eyepiece storage cases from $2⁴⁹.

Bolt-type containers protect eyepieces dew and dust. Foam inserts cradle eyepieces to protect them from accidents. Our website at **www.astronomics.com** lists which eyepieces fit into which containers (including other containers not listed below).

42mm x 60mm holds most Celestron NexStar, Meade Series 3000, and TeleVue Plössls.	**$2⁴⁹**
52mm x 80mm Holds TeleVue Radians, Nagler 6, most Barlows, large Celestron Ultimas, etc.	**$3⁴⁹**
65mm x 80mm Holds most illuminated reticles, 22mm Panoptic, 12mm Nagler, etc.	**$3⁹⁹**

The NexStar 11 got a rave review. You can have yours next week!

Celestron's 11" go-to GPS scope – the **NexStar 11 GPS** – got a *rave* review in *Sky & Telescope*. The review gave it "an enthusiastic two thumbs up and a gold star." They said it has "brains and good looks. The NexStar 11 GPS puts Celestron's time-tested 11-inch f/10 Schmidt-Cassegrain optics in a sleek new package that includes some of the most advanced electronics ever offered in a mass-produced telescope . . . Celestron is the first to take Go To scopes to the next step in their evolution, and it's a nice step indeed."

Multicoated optics are standard with the NexStar 11 GPS (other brands charge extra). We have the NexStar 11 in stock (36 as this was written). Call us and you can be observing with yours in about a week.

NexStar 11 GPS

$2999

> I wanted to thank everyone at Astronomics who have put up with my questions and additional questions. You have all been extremely helpful and patient with this first time telescope purchaser.
>
> **Customer Quote of the Month #129**

Multicoated optics are free on the NexStar 8 GPS.

NexStar 8 GPS

$2499

The in-stock 8" Celestron **NexStar 8 GPS** (24 on hand as this was written) has Starbright high transmission multicoated optics for brighter images at no extra cost. And you can easily convert its unique Fastar optics to a blazingly fast f/1.9 focal ratio for wide field CCD imaging.

With an optional Fastar lens assembly and a $1295 SBIG ST-237A CCD camera, the NexStar 8 GPS will record a huge 32 x 42 arc minute field. That's larger than the full Moon and more than three times the sky area imaged by a $7695 camera on other 8" scopes without Fastar!

Of all the computerized GPS scopes, *only the NexStars have multicoated Fastar optics at no extra cost!*

The new Celestron Modular i Series 8" GPS SCTs starts at only $1199!

NexStar 8i

$1199 shown with optional tripod and computer

If you compare, you'll see that the new **Celestron NexStar 8i** go-to costs less than comparably-equipped competitive 8" scopes. Starting at only $1199 for a complete working tabletop scope (not even available from the competition), you can add the options that you, and your budget, feel comfortable with. An *iCOMP* computer hand control with 40,000 deep space objects in memory is $149. A light weight travel tripod is $149. A heavy duty tripod (same as the NexStar 11 GPS) is $299. If you want the convenience of GPS auto-alignment, add it for only $199. However you outfit your NexStar 8i, it's enough scope to keep you observing for the rest of your life, at prices that leave competitive scopes behind.

A 5" GPS-ready scope starts at $899!

The **Celestron NexStar 5i** is the first 5" telescope to have a fully automatic GPS go-to computer available as an option. No other 5" scope has a GPS system! Even better, the modular nature of the NexStar 5i means that you can build up to a fully automatic GPS system gradually, starting at only $899 for a complete working tabletop scope. And multicoated optics are standard equipment with the NexStar 5i, not an extra-cost option as with other brands. NASA uses 5" Celestron multicoated optics on the Space Shuttle. Don't your eyes deserve the same premium images?

Sell your used telescopes and accessories quickly by using the classified ads you can run *for free* at

www.astrofieds.com

The Stellarvue refractor is a "hot new product."

AT1010A **$499⁹⁵**
shown w/optional diagonal and

The 80mm f/6 **Stellarvue AT1010** achromatic refractor was named a "Hot New Product of 2001" in the December 2001 issue of *Sky & Telescope*. Even better, independent user reviews say it competes favorably with ED semi-apochromatic telescopes that cost twice its modest price, and that it easily outperforms imported achromatic scopes in color correction and resolution. The AT1010A has hand-assembled and triple tested optics, tube rings, tripod adapter, 2" focuser with both 1.25" adapter and T-threads, red dot finder, oversize rubberized focus knobs for easier use in cold weather, and a soft padded carry case. It's a super deal and it's in stock to ship now.

Discovery Dobsonian reflectors start at only $339.

8" f/6 DHQ

$449

Why settle for an imported Dob when you can have made-in-the-USA quality *for less money!* Discovery doesn't use imported, mass-produced optics that are merely spot-checked to see if they're acceptable. Discovery optics are made in California by optical craftsmen, one quality mirror at a time. Each is hand figured to diffraction-limited performance, and it doesn't leave the Discovery optical shop until it's right.

Each DHQ series Dob has an adjustable metal primary mirror cell, a true *thin vane* adjustable 4-vane diagonal mirror spider, *two* Plössl eyepieces, a built-in tube balancing system, a tube carry handle, new oversized bearings, a 6 x 30mm finder, and a dust cover. You can get an upgrade kit that adds two more Plössl eyepieces, an eyepiece rack, a second dust cover, and a Moon filter for only $49 more!

Premium Dobs from 10" to 17.5" in aperture are also available. And for those who need big aperture portability, truss-tube Dobs are available in apertures from 12" to 24". Here are the Discovery 6" to 10" DHQ Dob prices:

6" f/5 Discovery DHQ	**$339⁰⁰**, plus $49 freight
6" f/8 Discovery DHQ	**$339⁰⁰**, plus $49 freight
8" f/6 Discovery DHQ	**$449⁰⁰**, plus $49 freight
8" f/7 Discovery DHQ	**$449⁰⁰**, plus $49 freight
10" f/4.5 Discovery DHQ	**$649⁰⁰**, plus $69 freight
10" f/5.6 Discovery DHQ	**$649⁰⁰**, plus $69 freight

24-Hour FAX line: (405) 447-3337 Our e-mail address: questions@astronomics.com

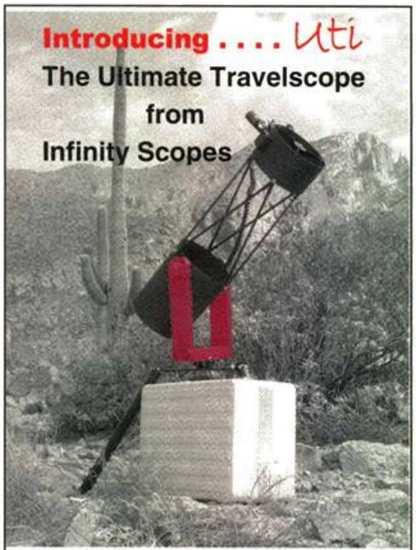
Our multiple award-winning Internet address: www.astronomics.com

STORE HOURS: 9-5 Monday thru Friday. Our phone lines are open 9 to 6 CST, Monday thru Friday, and most Saturdays from 12 to 5.

Mastercard, Visa, Discover, American Express. U. S. sales *only.*

No credit card surcharge. $6.95 minimum freight. All returns less freight. Restocking fees apply to returns for credit and to merchandise returned used or damaged.

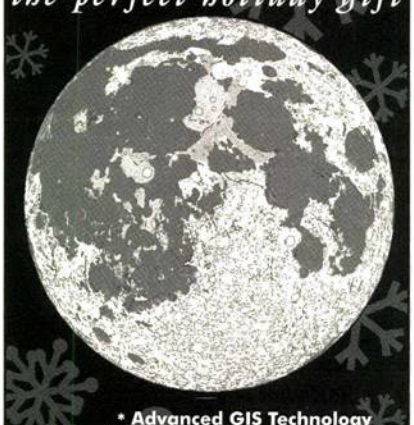
Introducing . . . . Uti
The Ultimate Travelscope
from
Infinity Scopes



The all-new Uti is ready to go viewing anytime, anywhere. The 8" Newtonian fits in an overhead bin size case, including tripod. Weighing only 22 lbs., the Uti sets up in less than 3 minutes. Comes equipped with a wireless Digital Locating system powered by Palm Pilot technology. Order Today!

Infinity Scopes, LLC
Tucson, AZ
www.infinityscopes.com
520-248-0932

moon software for windows
LUNAR MAP PRO™
the perfect holiday gift



- Advanced GIS Technology
- Nearly 13,000 lunar features
- Map flips, reverses, and rotates
- Personalized eyepiece FOV maps
- Accurately measures lunar distances
- Terminator corrected for libration
- User-selectable dates from 1970 to 2100
- Print beautiful custom moon maps
- Import your own lunar photos
- Personal observer's notebook
- See manned and unmanned landing sites
- And much more...

only **$89.95USD**

RITI
274 Main St., Ste. 302
Reading, MA 01867 U.S.A.
Tel:(01)781-942-1655
Fax:(01)781-942-2161
Email: ritisales@riti.com
visit www.riti.com

www.earthtreasuresmall.com
Exploration Encouraged

WEATHER STATIONS

Wireless & Cabled

TELESCOPES

EQ to GPS

MICROSCOPES

Beginner to Research grade

BINOCULARS

Birding, Nature, Sports & Astronomy

CELESTRON
MEADE
TELE VUE
DISCOVERY
LW SCIENTIFIC
DAVIS

"FROM THE MOLECULAR TO THE INFINITE"

EARTH TREASURES
12 MAIN ST. KEENE, N.H. 03431
PHONE-1-800-550-7192 FAX-603-352-5119
info@earthtreasuresmall.com

2002
ADORAMA
THE PHOTOGRAPHY PEOPLE
42 West 18th Street • New York, N.Y. 10011
800-223-2500

PROOPTIC

New Reduced Price

PLÖSSL 1.25" MULTI-COATED EYEPIECES

• Sharp detail • High contrast ghost-free images • Wide 50° apparent field of view (43° on the 40mm Plössl) • 4 element optics • Lens edges are blackened to keep out reflected light • Accepts 1.25" filters.

40mm	34.95	32mm	34.95
25mm	29.95	20mm	24.95
17mm	24.95	12.5mm	24.95
10mm	24.95	7.5mm	24.95
6.3mm	24.95		

SHORT TUBE BARLOW
Double the power of any eyepiece with this Barlow. Only 2¼" long.
only $29.95

New from
PRO-OPTIC
7mm-21mm Zoom
w/long eyerelief **$59.95**

NEW

90MM SPOTTING SCOPE / TELEPHOTO KIT
Kid includes 90mm optical tube, 25mm Plossl 1.25" eyepiece (20x) 45° Erect Image Diagonal & Deluxe Case

New Reduced Prices

$199.95
Shown with optional Tripod

15-45X FIELDSTAR SPOTTING SCOPE OUTFIT
Fully Coated, 2.25° f.o.v. at 15x, Long Eye Relief (33mm @ 15x) weighs only 25 oz, Rubber Coated includes Case & Table Top Tripod

New 15-45x Angle Spotting Scope Kit w/Case & Table Top Tripod **109.95**

$99.95

Slow Motion Control........ **$29.95**

45° Erect Image Diagonal 1.25"	29.95
90° Star Diagonal 1.25"	34.95
Straight Through Erector (Porro Prism)	64.95

WE BUY USED EYEPIECES & TELESCOPES

EYEPIECE FILTERS 1.25"
Available in the following colors: 1A Skylight; 8 Yellow; 11 Yellow Green; 12 Deep Yellow; 15 Deep Yellow; 21 Orange; 23A Red; 25 Red; 47 Violet; 56 Light Green; 58 Green; 80A Lt. Blue; 82A Pale Blue; ND 0.3; ND 0.6

1.25"@........9.95 Moon Filter 1.25" (ND 9X)........11.95
Buy any 4 filters (1.25")**only 34.95** **Buy any 12 filters........only 99.95**

4 PIECE FILTER SET WITH POUCH
Set #1 includes:
#12, 23A, 58 & 80A Packaged in a Pouch 34.95
Set #2 includes:
#11, 25A, 47 & 82A 34.95

PRO-OPTIC/HOWIE GLATTER LASER COLLIMATORS

Howie Glatter Skypointer Green Laser	199.95
ProOptic Ultra Bright Green Laser Pointer	174.95
Single Beam 1.25"	99.95
Holographic Laser Collimator 650NM 1.25"	149.95
Holographic Laser Collimator 635NM 1.25"	174.95
Single Beam 2"/1.25"	124.95
Holographic Laser Collimator 650NM 2"/1.25"	184.95
Holographic Laser Collimator 635NM 2"/1.25"	209.95
Holographic Laser Collimator 532NM 2"/1.25"	349.95
Scopetronix Laser Collimator 1.25"	64.95

TELESCOPE ACCESSORIES

DEW SHIELD
COLLAPSIBLE, FOLD DOWN, EASY TO STORE AND TRANSPORT

for Celestron C90	18.95	f/10" Schmidt Cassegrains	38.95
f/11" Scopes	49.95	f/5" Scopes	24.95

LUMICON FILTERS
UHC PREMIUM, DEEP SKY PREMIUM, H-BETA OR OXYGEN III
1¼"........99.50 48mm........199.95 2" T Mount........199.95
BUY ANY 2 FILTERS AND GET A 7% DISCOUNT

TELRAD FINDER

TELRAD with Base	36.95	Spare Mounting Base	7.95
Dew Shield for Telrad	11.95		

EASY TESTER
Optical Evaluation Eyepiece 29.95

JMI FOCUSERS

NGF-DX1	233.00	NGF-S w/Motofocus	234.00
NGF-DX2	180.00	NGF-DX3	144.00

SOLAR FILTERS GLASS

for Celestron C90/G3 & Meade ETX-90	59.95
for Tele Vue 101/102	59.95
for Tele Vue Pronto/Ranger Televue	49.95
for Celestron Nexstar 5" & Meade ETX-125	64.95
for Schmidt Cassegrains 8"	79.95
for Schmidt Cassegrains 10"	99.95
for Schmidt Cassegrains 11"	119.95

www.adorama.com

©2002

ADORAMA

THE PHOTOGRAPHY PEOPLE

42 West 18th Street (Bet. 5th & 6th Ave.) New York, N.Y. 10011
Email: info@adorama.com - **www.adorama.com**
ORDER TOLL FREE: USA / CANADA **800-223-2500**
ORDERS & INFORMATION: **212-741-0052**
CUSTOMER RELATIONS: **800-815-0702 / 212-741-0466**
Mon-Thur. 9:00-4:30, Fri. 9-1, EST FAX: **212-463-7223**

CELESTRON

$500⁰⁰ CASH REBATE
From Celestron
Expires 10/31/02

SCHMIDT CASSEGRAIN

Celestar 8	849.95
G-8 German Eq. 8"	Call
G-5 w/Equatorial Mount	Call

CELESTRON NEXSTARS

Nexstar 4	539.95
New Nexstar 5 I	Call
New Nexstar 8 I	Call
Nexstar 8 GPS	Call
Nexstar 11 GPS	Call

NexStar™

NEXSTAR SERIES

Nexstar 60-GT	219.95
Nexstar 80-GT	Call
Nexstar 60/80 Soft Case	79.00
Nexstar 80/114 Hard Case (for Scope only)	99.00

NEXSTAR 114 REFLECTOR

Nexstar 114 GT	Call

SPOTTING SCOPES

80mm Wide Field	Call
102mm Wide Field	Call

REFLECTORS

G-8N Reflector 8"	449.95
C-150 H.D. 6"	Call

CELESTRON REDUCER/CORRECTOR F/6.3

Works with all Current Celestron and Meade Schmidt Cassegrains. Now it is possible to have a dual focal ratio instrument without sacrificing image quality. The Reducer/Corrector is f/6.3 for C8 and C11, f/7 for C14. A four element, fully multi-coated accessory. Results are amazing BOTH visually and photographically.

114⁹⁵

CELESTRON TELESCOPE ACCESSORIES

AC Adpt. f/Nexstars	19.95
Car Batt. Adpt. f/Nexstars	19.95
2X Barlow 1.25" Short Tube	39.95
Counterweight Bar Assembly 8"	84.95
Case for C8/C5	179.95
Piggyback Mt 8"	34.95
Piggyback Bar Assembly 11"	69.95
Folding Lens Shades	Call

MOTORS

Single Axis Motor for CG-5	109.95
Dual Axis Drive for CG-4	159.95
Dual Axis Drive for CG-5	169.95

CELESTRON FILTERS

LPR A	59.95
LPR B	84.95
Pol. Set 1¼"	44.95
Sky Filter #2	44.95
4 piece 1.25" Filter Set	46.95

DIAGONALS

Diagonal Erect 1¼" 45°	39.95
Hybryd Diagonal .96" 1¼" 45°	39.95
Diagonal Erect 1¼" 90°	49.95
Star Diagonal 1¼" 90°	33.95
2" Mirror Star Diagonal	124.95

CELESTRON STEREO

Binocluar Viewer	479.95
T- Adapter for ETX's	24.95

ULTIMA EYEPIECES

5mm, 1¼"	67.95	7.5, 1¼"	67.95
12.5mm, 1¼"	67.95	18mm 1¼"	67.95
30mm, 1¼"	84.95	42m, 1¼"	89.95
35m 1¼"	96.95		
2X Ultima Barlow Lens	62.95		

JMI ACCESSORIES FOR NEXSTAR 5/8

Motofocus	101.95
NGFS Motor Folos For Smit Case	239.95
Carry Case	129.95
Celestron Case	149.95

FINDERSCOPES

9x50 Finderscope Kit	79.95
7x50 Polaris Finder Scope with Illuminator & Bracket	159.95
Quick Release f/7x50 find	42.95
Star Pointer Finderscope	21.95
Polar Axis Finder f/CG-4/5	39.95

GUIDING SYSTEM

Radial Guider	79.95
Micro Guide Eyepiece	134.95
10mm Plossl Reticle	84.95
20mm Cross Hair Eyepce.	34.95
Standard Illuminator	39.95

TRIPODS & MOUNTS

Heavy Duty f/ Nexstar 5/8	274.95
CG-5 Equatorial Mnt.	359.95
Vibration Suppression Pads	39.95

NIGHT VISION ASTROLIGHTS

Night Vision LED Light	16.95

T-ADAPTER/TELE EXTENDERS

Tele Extender Deluxe	48.95
T-Adapt. f/Schmidt Cassegrains	24.95
T-C 16mm Adapter	29.95

NEXSTAR PLOSSL EYEPIECES 1.25"

3.6,6,8,10,13,17,25mm	39.95
32, 40mm	49.95

AXIOM EYEPIECES

15mm 1¼"	129.95
19mm 1¼"	139.95
23mm 1¼"	149.95
19mm 2"	169.95
34mm 2"	209.95
40mm 2"	249.95
50mm 2"	274.95

ASTRONOMY SOFTWARE

THE SKY FOR WINDOWS 95

Sky Level 2 or 3	Call
Sky GSC (CD ROM) Level 4	Call
Starry Night Pro	119.95

NEW FROM STARRY NIGHT YOUR UNIVERSE IN 3-D

Deep Space Explorer	49.95

STARRY NIGHT SOFTWARE CALL

TheSky
starry night beginner
Ver 5.0

Tele Vue®

WE STOCK THE COMPLETE LINE OF TELE VUE TELESCOPES EYEPIECES & ACCESSORIES

VIXEN LANTHANUM EYEPIECES

EYEPIECES LV SERIES

2.5mm,	99.95	4mm	99.95	5mm	89.95
6mm	89.95	9mm	89.95	10mm	89.95
12mm	99.95	15mm	89.95		

LV ZOOM

8-24mm Zoom	149.95

PENTAX

XL SMC EYEPIECES

5.2, 7, 10.5, 14, 21, 28mm, 1.25"	219.95
40mm, 2"	234.95
8-24mm Zoom	349.95

BUSHNELL

COMPACT 4.5" REFLECTOR

Features a unique cradle mount which is convenient to use and transport. A wide field of view makes it easy to locate objects and keep them in view

- Aperture: 4.5"
- Focal Length: 400mm
- Eyepieces: 1.25" 4mm (100X), and 25mm (16x)
- Focuser: Precision Rack & Pinion, Tripod adaptable, includes convenient shoulder strap

159.95

DIGITAL ASTRO PHOTOGRAPHY

DIGI-T DIGITAL CAMERA ADAPTER

Fits onto most 1.25" eyepieces *(with Removable Eyeguards)* and allows you to attach it to a Digital Camera

Following is a list of kits we carry for particular cameras

Kit f/Nikon Coolpix 995	59.95
Kit f/Nikon Coolpix 775/885/880/5000	89.95
Kit f/Canon G-1/G-2	89.95
Kit f/Olympus 2/3000	89.95

Also available for many other cameras call f/details

Adapta View Camera Adapter f/Tele-vue & Meade Large Eyepieces	39.95

NEW

DIGITAL CAMERA ADAPTERS

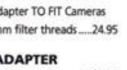
allows you to connect your camera direct to a telescope (requires a T-Adapter)

Digital Camera Adapter TO FIT Cameras with 28/37/49/52mm filter threads	24.95

MICROSCOPE TO DIGITAL CAMERA ADAPTER

Uni-Adapt Adapter f/Larger Eyepieces, Spotting Scopes & Microscope	164.95

This adapter fit on all eyepieces or mounting areas from 14mm-55mm. This should fit just about every spotting or microscope, and most digital/Video cameras with filter treads or optional thread adapters, units are made from anodized aluminum.



NIGHT NAVIGATOR

THE ELECTRONIC STAR LOCATOR

LOCATES AND IDENTIFIES CONSTELLATIONS QUICKLY.

- Scientific patented computer tracking system to accurately locate and identify constellations, planets, and stars quickly and effortlessly.
- Innovative built-in digital electronic compass automatically plots your location. • Motorized map delivery system for easy sky navigation.

79.95

BINOCULARS

PROOPTIC

New Reduced Prices

These binoculars with their large objectives high quality BAK-4 prisms will provide you with breathtaking wide-field observation of astronomical objects as well as terrestrial viewing under low light conditions.

Each binocular is provided with a high quality Hard Case, Neck Straps and Rubber Eye-Cups.

25 Year Warranty

70MM JUMBO FULLY MULTI-COATED SERIES/RUBBER COATED

11x70 Jumbo – 4° field of view, 21mm eye relief, R.C.weighs 2.8 lbs.	159.95
16x70 Jumbo– R.C. 3.6° field of view, weighs 2.8 lbs.	174.95

80MM GIANT FULLY MULTI-COATED SERIES

20x80 Giant – 3.3° field of view, 14mm eye relief, weighs 5.25 lbs.	259.95

100MM ULTRA GIANT SERIES

The ultra large aperture of 100mm provides more than 50% more light gathering power than the standard 80mm Giant Binoculars. For a delightful experience in astronomical viewing. Both feature multi-coated optics, BAK-4 prism, built-in platform which mounts on a tripod.

25x100 Ultra Giant	89995

Canon

IMAGE STABILIZED

18x50	Call	15x50	Call
12x36	Call	10x30	Call
New 8x25 Compact	Call		

WATERPROOF

8x32	129.95	8x23	84.95

COMPACT

10x25	69.95
8x23 Porro Prism	44.95

ULTRA COMPACT

5x17	59.95	7x17	74.95

CELESTRON®

PRECISION OPTICS

GIANT

20x80 Deluxe	Call

NOBAL FULLY PHASE COATED

8x42	279.95	10x42	299.95

REGAL FULLY MULTI COATED

8x42	274.95	10x50	289.95

ULTIMA

7x50	Call	8x40	Call
8x56	Call	9x63	Call
10x50	Call		

TRAVELER MULTI COATED

10x25	46.95	8x21	39.95
7x16x25 Zoom	69.95		

MONOCULAR

8X25	34.95

FUJINON

F-SX SERIES

7x50 FMT SX	Call
7x50 FMTR SX	Call
7x50 FMTR CSX	Call
8x30 FMTR SX	Call
10x70 FMT SX	Call
16x70 FMT SX	Call

BIRDING SERIES (BFL)

8X42	Call
Marine Waterproof 7x50 XL w/Compas	159.95

CD WATER PROOF RP

10x42	Call

TECHNO STABI

14x40	Call

SPOTTING SCOPES

KOWA 82mm

NEW MODIFIED VERSION

W/20 TO 60X ZOOM

TSN-821M	819.	TSN-822	794.
TSN-823M	1229.	TSN-8248M	1209.

W/O EYE PIECE

TSN-821M	559.	TSN-822M	534.
TSN-823M	969.	TSN-824M	949.
27x L.E.R.	139.95	32x w.a.	199.95
20-60x Zoom Eyepiece	284.95		
PA2-C 82mm Photo Adapt.	174.95		
20-60x f/60mm	144.95		

WE ALSO CARRY A FULL LINE OF
Pentax, Leica, Nikon, Bushanell, Bausch & Lomb, Zeiss, Minox, Spotting Scopes

DIGITAL CAMERAS

Canon
POWER SHOT G2
Call

Nikon
COOL PIX 5000
Call

CANON CAMERAS

Power Shot S200	Call
Power Shot S330	Call
Power Shot S30/S40	Call
Power Shot A40	Call
Power Shot A100	Call

OLYMPUS

E-20N 5 Meg, 4x ZM Dual Media	***Call***
E-10 Digital SLR,4 Mega pixel, 4X zoom	***Call***
C4040Z 4 Meg. 2.5x Dig. Zoom	**Call**
C4000Z	**Call**
C700 Ultra ZM 2.1 Meg. 10x Opt.	**Call**
C720D Ultra ZM 3. Meg. 8x Opt.	**Call**
D40 Zm 4 Meg. 2.8 Optical Zm 2.5x dig.	**Call**
D550 3. Meg. 2.8 Opti. 3.6 Dig. Zoom.	**Call**
D520 2.1 Meg. 3X Opt. ZM 2.5 Dig. ZM	**Call**
D380 Dig Zoom 2.0 Megapixel	**Call**

NIKON CAMERAS

Coolpix 885	Call	Coolpix 2500	Call
Coolpix 2000	Call	Coolpix 4300	Call
Coolpix 4500	Call	Coolpix 5700	Call

SONY

SONY CAMERAS

MVC CD-250 CDR 2.0 Mega Pixel w/3x Zoom	**Call**
MVC CD-300 CDR 3.3 Mega Pixel w/3x Zeiss Zoom	**Call**
MVC CD-400 CDR 4.0 Mega Pixel w/3x Zeiss Zoom	**Call**

MAVICA FLOPPY CAMERAS

MVC-FD73	**249.95**	MVC-FD75	**Call**
MVC-FD100	**Call**	MVC-FD200	**Call**

CYBER SHOT CAMERAS

DSC-F707 5 Mil Pix 5x Zoom	**Call**
DSC-P31 1.3 Mil Pix 3x Zoom	**Call**
DSC-P9 3.3 Pixel 5x Zm Ultra Comp	**Call**
DSC-P51 2.1 Mil Pixel 3x Zoom	**Call**
DSC-P71 3.3 Mega Pix 3x Zoom	**Call**
DSC-S75 3.34 Mega Pix 3x Zoom	**Call**
DSC-S85 4.1 Mega Pix 3x Zoom	**Call**

WE SHIP PROMPTLY ALL TELESCOPES INCLUDE U.S.A. WARRANTY

No Surcharge for MasterCharge or Visa Purchases. Personal checks welcome, will ship without delay. Name must be imprinted on check, also include address, phone, and a copy of major credit card or driver's license for reference. Shipping, handling and insurance additional. 14 day money back guarantee less shipping, with packing and blank warranty card, except film and paper. We ship UPS. Some items special order. All orders are subject to acceptance and verification. Second hand dealer's license #802862. Pictures are for illustration purposes only and may not be exact. Wa are not authorized Meade dealers.

Prices effective till Nov. 10, 02 **Please address all inquiries and orders to ASTRO. DEPT. #55**

Your Credit Card Will Only Be Charged At Time Of Shipping For Items Actually Shipped

ACTIVE GALAXIES

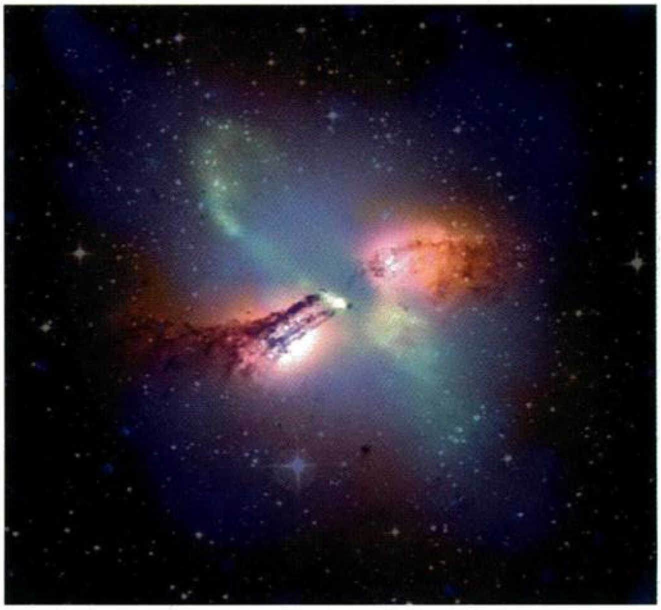
Explosion Rocks Centaurus A

Supernovae shine with the light of 100 billion stars. Gamma-ray bursts gleam even brighter. But if a team of astronomers from the Harvard-Smithsonian Center for Astrophysics is right, an eruption that ripped through the bright galaxy Centaurus A 10 million years ago may put both types of explosion to shame.

The team used the Chandra X-ray Observatory to study Centaurus A, an active galaxy located 11 million light-years from Earth. They found two huge arcs of multi-million degree gas that appear to be part of a ring that spans 25,000 light-years. But to really figure out what was going on, the astronomers had to combine the Chandra x-ray observations with earlier optical and radio images.

"Putting all the images together was the key to understanding what Chandra showed," says team leader Margarita Karovska, who reported the results in the September 20 issue of *The Astrophysical Journal.* "Suddenly it all clicked, as with a giant puzzle, and the images fit together to make a complete picture of the galaxy's geometry that was not at all apparent before."

The combined image showed opposing jets of high-energy particles bisecting the broad band of dust and cold gas familiar to anyone who has observed this enigmatic galaxy. The two large arcs of x-ray-emitting gas lie in a plane perpendicular to the jets, which are seen blasting away from the presumed supermassive black hole in the galaxy's nucleus.



Turmoil reigns in the active galaxy Centaurus A. This composite of x-ray (blue), radio (pink and green), and optical (orange and yellow) images reveals two arcs of hot, x-ray-emitting gas that astronomers think were created in an explosion some 10 million years ago.

X-ray: NASA/CXC/M. Karovska et al.; 21-cm radio: NRAO/VLA/Schiminovich et al.; radio continuum: NRAO/VLA/J. Condon et al.; optical: Digitized Sky Survey U.K. Schmidt Image/STScI

The team proposes that the orientation of the arcs and the symmetry of the ring are evidence that the ring resulted from a giant eruption in the nucleus some 10 million years ago. The explosion would have produced a galaxy-sized shock wave that has been moving outward at a million miles per hour ever since. The age of the outburst matches other observations, which show the rate of star formation jumped dramatically at about the same time.

"Active galaxies could have played a significant role in the evolution of galaxies in the early universe, when collisions between galaxies were much more frequent," says team member Giuseppina Fabbiano. "Centaurus A gives us a rare opportunity to study a nearby, active galaxy in action." — RICHARD TALCOTT

PLANETARY SCIENCE

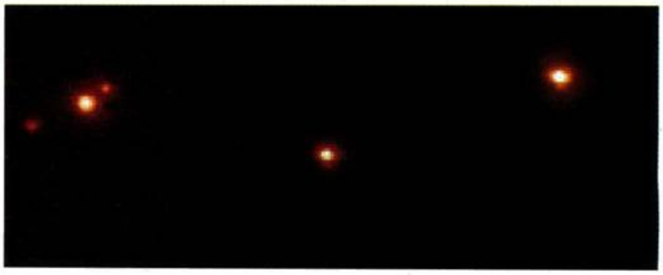
Global Cooling Strikes Pluto

When Pluto passed in front of a star this summer, it confirmed suspicions that the distant planet's atmosphere changes during its 248-year journey around the Sun. The new observations, however, also suggest that the changes are even more drastic than imagined.

As solar system objects orbit the Sun, occasionally they pass between Earth and a star, an event known as an occultation. If the object has an atmosphere, astronomers can scrutinize the star's light just before and after the object blocks the star. Careful observations can reveal details about the density, temperature, and pressure of the object's atmosphere.

On July 19, Marc Buie of Arizona's Lowell Observatory set up a portable 14-inch telescope in northern Chile to watch Pluto occult a star called P126A. Because

Pluto (the brightest point at left) and its moon, Charon (to Pluto's lower left), passed in front of the triple star P126 (the other three points of light) on July 19, 2002. Observations of this occultation show Pluto has cooled significantly over the past 14 years. European Southern Observatory

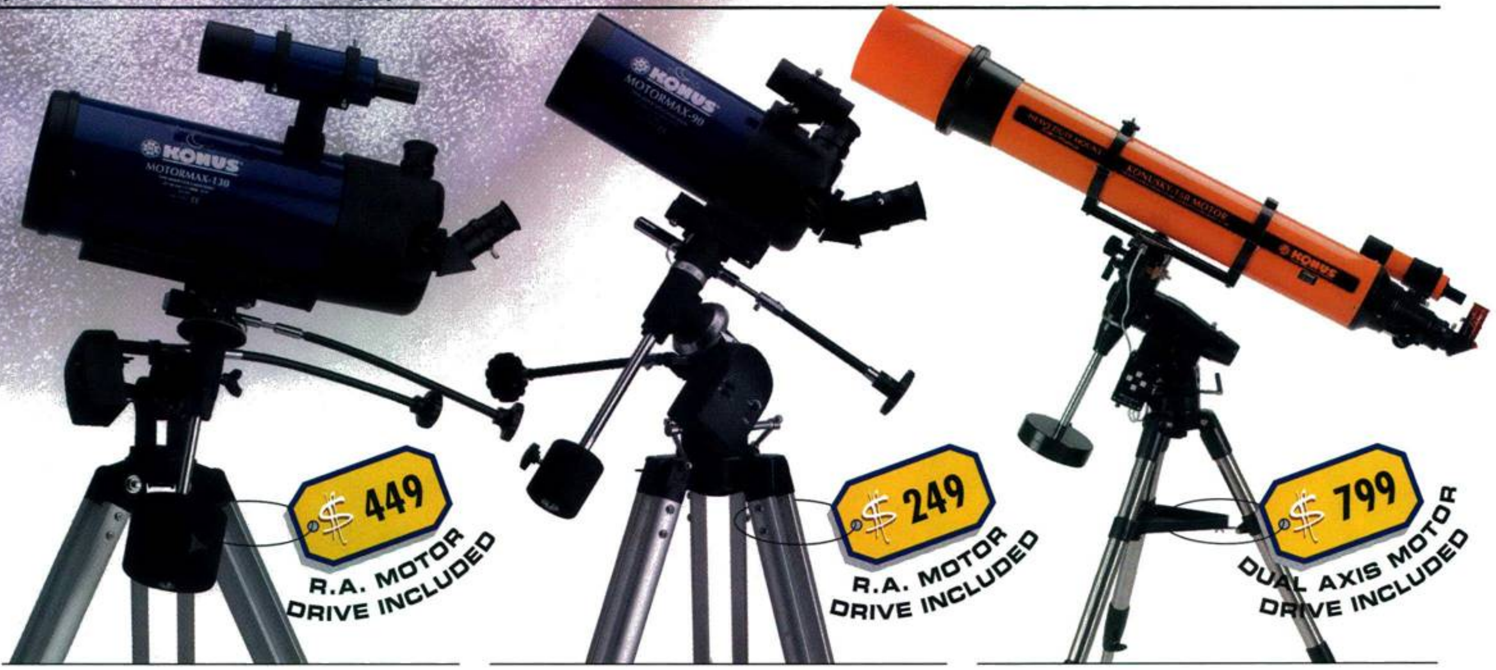


KONUS®

Optical & Astronomy Systems

KONUS USA CORPORATION
8359 NW 68 STREET - MIAMI, FL 33166
Tel. +1-305-5925500
Fax +1-305-5926255
e-mail: konususa@bellsouth.net
www.konus.com

After more than 20 years of growing success as a telescope specialist in Europe, KONUS has now begun offering its finest products to the American market. We are introducing a selection of diffraction limited Refractor, Reflector and Maksutov-Cassegrain models that feature uncompromising optical and mechanical quality at never-before-seen prices. Standard equipment on all featured models includes **a free Dual-Axis or R.A. motor drive** while most models also carry **two professional 1.25" Plossl eyepieces** as an additional value.



KONUS
MOTORMAX-130
$ 449
R.A. MOTOR DRIVE INCLUDED
KONUS
MOTORMAX-90
$ 249
R.A. MOTOR DRIVE INCLUDED
KONUS
$ 799
DUAL AXIS MOTOR DRIVE INCLUDED

# 1797 MotorMax-130: 5.1" (130mm) f/2000 fully multi-coated Maksutov-Cassegrain with double mirror star diagonal (45° and 90°). Includes: **R.A. MOTOR DRIVE, 10x50 FINDERSCOPE AND TWO 1.25" PLOSSL EYEPIECES** (10mm & 17mm).

# 1795 MotorMax-90: 3.5" (90mm) f/1200 fully multi-coated Maksutov-Cassegrain with double mirror star diagonal (45° and 90°). Includes: **R.A. MOTOR DRIVE, 8x21 FINDERSCOPE AND TWO 1.25" PLOSSL EYEPIECES** (10mm & 17mm).

#1790 Konusky-150: 6" (150mm) f/1200 fully multi-coated Refractor. Includes: **DUAL AXIS MOTOR DRIVE, PROFESSIONAL STEEL TRIPOD, BUILT-IN POLARSCOPE, TWO 1.25" PLOSSL EYEPIECES** (10mm & 17mm).

#1793 Konusky-200: 8" (200mm) f/1200 Newtonian Reflector with Parabolic mirror. Includes: **DUAL AXIS MOTOR DRIVE, PROFESSIONAL STEEL TRIPOD, BUILT-IN POLARSCOPE, TWO 1.25" PLOSSL EYEPIECES** (10mm & 17mm).

# 1784 Konusmotor-114: 4.5" (114mm) f/900 Newtonian Reflector. Includes: **R.A. MOTOR DRIVE AND TWO 1.25" PLOSSL EYEPIECES** (10mm & 17mm).

# 1780 Konusmotor-500: 4.5" (114mm) f/500 short tube Newtonian Reflector. Includes: **R.A. MOTOR DRIVE, MOON FILTER, TWO 1.25" EYEPIECES.**

# 1778 Konusuper-120: 4.75" (120mm) f/1000 fully multicoated Refractor. Includes: **DUAL AXIS MOTOR DRIVE, PROFESSIONAL STEEL TRIPOD, BUILT-IN POLARSCOPE, TWO 1.25" PLOSSL EYEPIECES** (10mm & 17mm).

# 1783 Konusmotor-90: 3.5" (90mm) f/900 fully multi-coated Refractor. Includes: **R.A. MOTOR DRIVE AND TWO 1.25" PLOSSL EYEPIECES** (10mm & 17mm).

* Prices do not include shipping & handling charges.

Konus USA Corporation does not sell directly to the public. Therefore, we ask that you submit your inquiries to one of the following Authorized Dealers. Check our website for more Dealers

SCOPE CITY • www.scopecity.com
Simi Valley, CA: (805) 522-6646
Sherman Oaks, CA: (818) 789-5805
Costa Mesa, CA: (714) 957-6900
San Diego, CA: (858) 277-6686
San Francisco, CA: (415) 421-8800
Las Vegas, NV: (702) 947-2673

RIVERS CAMERA • www.riverscamera.com
Dover, NH: (800) 245-7963

HARDIN OPTICAL • www.hardinoptical.com
Bandon, OR: (877) 447-4847

EDMUND SCIENTIFIC • www.scientificsonline.com
Tonawanda, NY: (800) 728-6999

HANDS ON OPTICS • www.handsonoptics.com
Damascus, MD: (866) 726-7371

B & H • www.bhphotovideo.com
New York, NY: (800) 947-9970

STELLAR VISION • www.azstellarvision.com
Tucson, AZ: (520) 571-0877

LAND SEA & SKY • www.lsstnr.com
Houston, TX: (713) 529-3551

DIGITEC OPTICAL • www.mwetech.com
Levittown, NY: (516) 735-4440

EAGLE OPTICS • www.eagleoptics.com
Middleton, WI: (800) 289-1132

STAR SAFARIS • www.starsafaris.com
Chico, CA: (530) 879-0207

ASTROSTUFF • www.astrostuff.com
Dover, AR: (479) 331-3773
Belgrade, MT: (406) 388-1205

ADORAMA • www.adorama.com
New York, NY: (800) 223-2500

CANADA: KHAN SCOPE CENTRE
Toronto, ON: (800) 580-7160
www.khanscope.com

UNITED KINGDOM: SWAINS INTERNATIONAL - Hunstanton Norfolk
44 (0) 1485 536200 sales@swains.co.uk

STUDIO POLACCO & Co.-Vr Italy

Pluto appears so small — its disk spans barely 0.1" — occultations are rare. The July event was the first one observed successfully since 1988. Afterward, Buie and James Elliot of the Massachusetts Institute of Technology compared the results of the two occultations.

"In the last 14 years, one or more changes have occurred," Buie says. "Pluto's atmosphere is undergoing global cooling, while other data indicate that the surface seems to be getting slightly warmer. Some change is inevitable as Pluto moves away from the Sun, but what we're seeing is more complex than expected."

From the earlier occultation and other observations, planetary scientists learned that Pluto has a thin atmosphere with nitrogen and some methane and carbon dioxide. In 1988, the occulted star's light dipped slightly at first before plunging sharply. This unexpected behavior suggested that Pluto's atmosphere could have a smog layer, or the temperature drops suddenly near the planet's surface.

In contrast, the July event provided a much smoother light curve, suggesting the cause of the abrupt drop witnessed in 1988 is no longer present. Additionally, the recent results show that Pluto's atmosphere has cooled between 20° and 55° Fahrenheit.

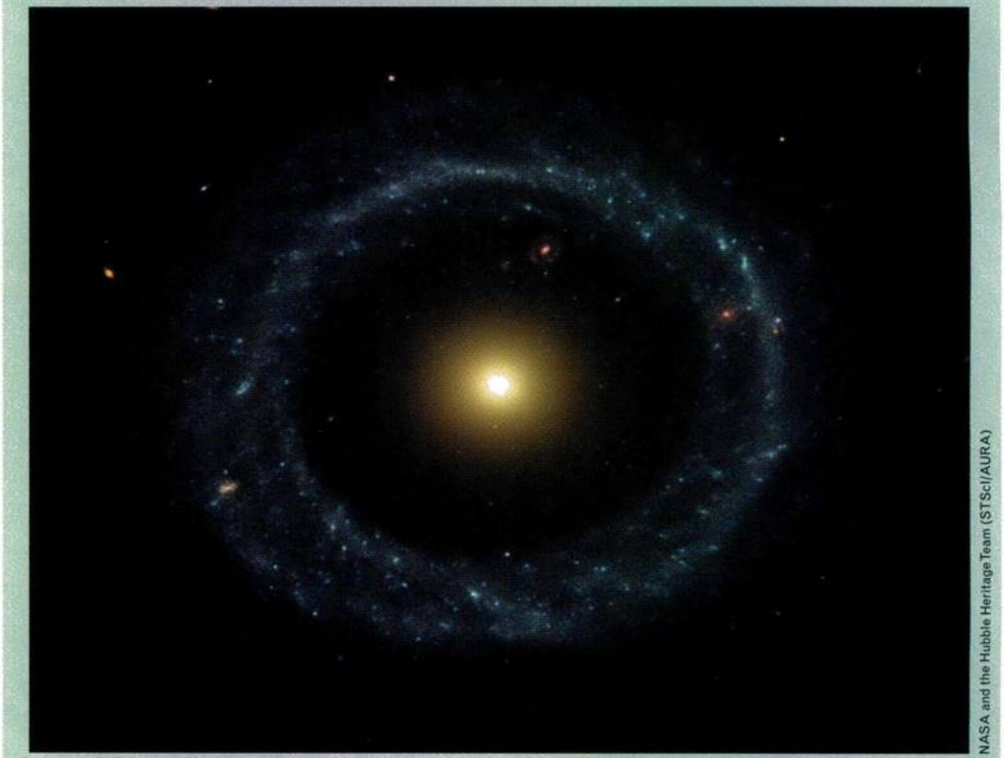
"A 1997 Triton occultation revealed that the surface of Triton, Neptune's largest moon, had warmed since the Voyager spacecraft first explored the moon in 1989," Elliot says. "But the changes seen in Pluto's atmosphere are much more severe."

"We cannot fully explain what has caused these dramatic changes to Pluto's atmosphere," Buie adds. "A mission to Pluto is our best hope for putting all the puzzle pieces together."

For years, NASA has included a spacecraft to Pluto in its plans, but budget problems have repeatedly delayed the mission. Last year, the U.S. Congress awarded a modest amount of funding to begin developing the New Horizons mission to Pluto, its moon, and the Kuiper Belt, but future financial support remains uncertain.

— Vanessa Thomas

HUBBLE SPACE TELESCOPE



NASA and the Hubble Heritage Team (STScI/AURA)

CLUSTERS OF HOT, YOUNG STARS pepper a ring that spans 120,000 light-years in the galaxy known as Hoag's Object. This Hubble image clearly shows the ongoing star formation, with blue light radiating from massive stars packed into the dense star clusters that form the ring. It surrounds a yellow nucleus of older stars that appears to be a normal elliptical galaxy. Yet the nature of Hoag's Object remains puzzling. Astronomers suspect that the ring formed when a second galaxy passed the elliptical one, which shredded the interloper and captured its material into orbit. If so, the encounter likely occurred 2 billion to 3 billion years ago — long enough that any tidal structures would have disappeared. Interestingly, a second ring-shaped galaxy appears in the background, in the gap between the nucleus and ring, at about the one o'clock position.

NEUTRON STARS

Magnetars Multiply

▶ Observations by NASA's Rossi X-ray Timing Explorer satellite have doubled the known number of rare and highly magnetic stars astronomers call magnetars. A class of x-ray-producing neutron stars, which had previously defied explanation, appears to share a number of characteristics with this super-magnetized stellar species.

In 1982, astronomers discovered a neutron star emitting regular pulses of x-ray radiation, but for 20 years couldn't explain how the star was producing such emissions. Since then, only four more of these "anomalous x-ray pulsars" (AXPs) have been found.

A few years before astronomers uncovered the first anomalous x-ray pulsar, they also identified another unusual type of

We Can Take You There!

Unique Astronomy Tours

Alaska Aurora Viewing · Mar. '03
Arizona Deep Skies · May '03
Greenland Annular Eclipse · May '03
Antarctica Total Eclipse · Nov. '03

TRAVELQUEST International

Call for FREE brochures: 800.830.1998
www.tq-international.com

DID YOU EVER....
...wonder how it feels to pick up a finely machined Questar?
...wonder how it feels to see the polish and fit and attention to detail?
...wonder how it feels to adjust the controls so smoothly?
...slam the door of an imported rental car and wonder what it would be like to drive a Ferrari?
...wonder what its like to look through the best optics in the world?
...wonder why a Questar is passed from one generation to the next?
...wonder why a Questar that someone bought in 1971 for $995 and used for 30 years, could still be sold for over $2000?
...take a picture with a plastic point and shoot and then pick up and hold a Leica or Hasselblad?
...smell the hand crafted leather of a Questar carrying case?
...wonder why Questars flew on space missions, were used in Desert Storm and are used by very elite special forces all around the world?
...wonder why every component of a Questar is very precisely manufactured in the USA?
...see the silk screened star chart and moon map up close?
...wonder why there is absolutely no plastic on a Questar?
...wonder how many different accessories come standard with a Questar?
...know you want one and you know someday you'll get one - - **But why wait?**

www.QuestarCorporation.com 800-247-9607

QUESTAR. The Optical Innovators

KENDRICK ASTRO INSTRUMENTS

SOLAR FILTERS
DEW REMOVERS
KWIK FOCUS
OBSERVATORY TENTS
DEW CAPS
LASERS
OBSERVING CHAIRS
POWER PACKS

Shop on-line at www.kendrick-ai.com or visit our showroom

POWER PACKS

12V 18 AH battery	$125
12V 18AH dual plug battery	$175
12V 18AH dual plug battery (Nexstar)	$215
12V/18V 18AH dual plug battery	$285
12V 33AH battery	$290
12V 33AH battery (Nexstar)	$330
18V 33AH battery	$390

TENTS

Observer Tent	$390
Shelter Dome	$299
Shelter Dome Rain Fly	$95

DEW REMOVER SYSTEM

controller	$70
.965"	$33
1.25"	$35
2"	$37
3"	$40
4"	$43
5"	$45
6"	$48
7/8"	$50
9/10"	$60
11"	$65
12"	$70
14/16"	$80
Telrad Heater	$23
Telescope computer control heater	$35

Heaters for Newtonians available

2920 Dundas St. W. Toronto, On. M6P 1Y8
1-800-393-5456 phone 416-762-2765 fax

HOME-DOME® and PRO-DOME™

HD10 in Colorado Springs, CO

- True Rotating Dome
- Easy Assembly
- 6, 10, 15ft. Diameter
- All Fiberglass
- Motors & Automation
- Wide Slot Openings
- Complete Systems Priced from $2350

NEW - ROBO-FOCUS™
Automated Focus Driver
with temperature compensation
$375

Technical Innovations, Inc.
7851 Cessna Ave.
Gaithersburg, MD 20879
Ph: 301-977-9000 • Fax: 301-977-1106

FREE BROCHURE
www.homedome.com

Share the View

Meade
Takahashi
Tele Vue
authorized dealer

FREE SHIPPING on Most Items we Sell!

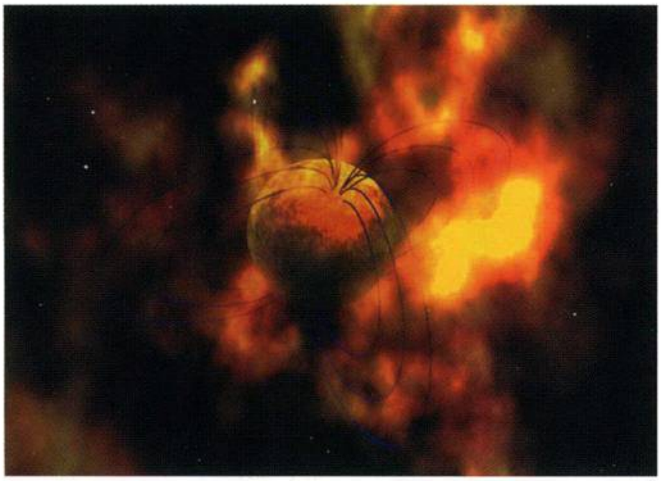
with our New Color Sky-Cam II Video Camera
$199.95

NEW
Sky-Cam USB Interface for PC and Mac $49.95*

* price valid only for Sky-Cam II Customers

AstronomyQuest.com

1-800-807-8763 www.AstronomyQuest.com
4790 Irvine Blvd. Suite 108, Irvine, CA 92620



The discovery of five new magnetars — neutron stars possessing extraordinarily intense magnetic fields — has doubled the known number. The blue lines emanating from the poles of the magnetar in this artist's depiction represent its powerful magnetic field.

Robert Mallozzi (University of Alabama, Huntsville)

neutron star which gives off bursts of low-energy, or soft, gamma rays. Like the AXPs, just five of these "soft gamma-ray repeaters" (SGRs) have been found so far. In the mid-1990s, new evidence showed that SGRs possess magnetic fields a thousand times stronger than ordinary neutron stars, which are already highly magnetized, and trillions of times stronger than the Sun's. This extraordinary fountain of magnetic energy is the source of SGR bursts, and the objects were dubbed magnetars.

Some astronomers and theorists expected that AXPs might also be magnetars, but until now, there was no evidence that AXPs experience bursts like their soft gamma-ray cousins. In the September 12 issue of *Nature*, however, a team led by researchers from McGill University in Montreal, Canada, reported the first recorded bursts from an anomalous x-ray pulsar. The finding suggests that AXPs are also endowed with powerful magnetic fields, which drive the stars' x-ray pulses.

"People have suspected for years that these bizarre AXPs might be magnetars," explains team member Victoria Kaspi of McGill, "but at last we have definitive proof. We finally caught one bursting, just like a magnetar."

The Rossi X-ray Timing Explorer satellite witnessed the telltale bursting from a source called AXP 1E 1048–5937, located at least 8,000 light-years from Earth in the southern constellation Carina. These bursts are the latest behavior in a list of attributes that made astronomers imagine AXPs might be magnetars.

"It is the combination of similarities in spin parameters, spectra, and especially now the bursting that provide a compelling link between AXPs, SGRs, and magnetars," says McGill graduate student Fotis Gavriil, the lead author of the *Nature* report.

The finding doubles the number of known magnetars from five to ten. — V. T.

EXTRASOLAR PLANETS

A Planet Bites the Dust?

With more than 100 trophies in tow, it seems that everywhere extrasolar planet hunters look, they find their prey. But in one case, they may just be seeing spots.

Astronomer Greg Henry of Tennessee State University reports that the planet "discovered" two years ago around the star HD 192263 is probably illusory, and that what astronomers had actually seen were starspots, similar to those on our Sun. But one of the teams that discovered the planet doesn't want it to be written off yet.

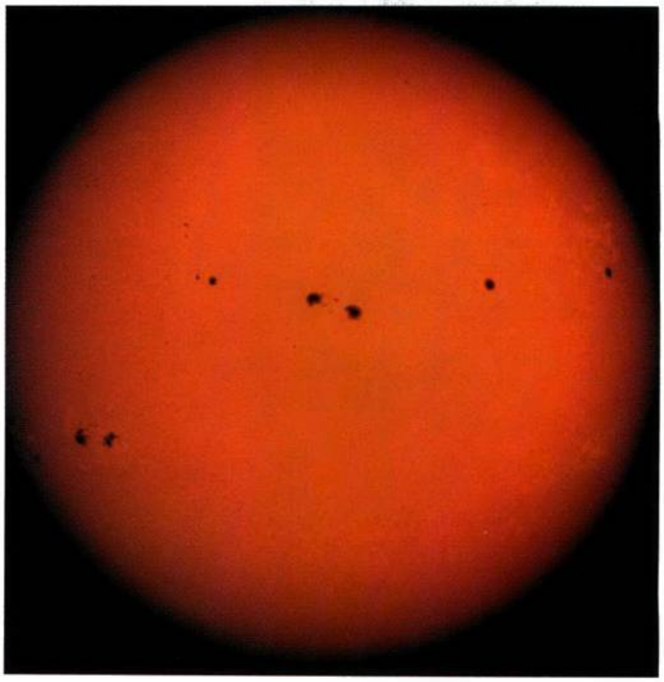
The confusion comes from how most extrasolar planets are detected. Because an orbiting planet tugs on its host star, the star's light alternately gets stretched (redshifted) and contracted (blueshifted) as the star wobbles to and fro. This is known as the radial velocity, or Doppler, method.

Spots can also affect a spectrum. Because stars rotate, the light from the side of the star approaching Earth appears blueshifted, while the light on the receding side is redshifted. When a starspot comes into view, it covers up some of the blueshifted light, and when it begins to rotate out of view, it covers up some of the redshifted light.

"That simple effect can cause the appearance of a Doppler shift," says Henry, who published his results with two co-authors in the October 1 issue of *The Astrophysical Journal*. "Not a particularly large shift, but on the same order of size seen in extrasolar planets."

As a result, in questionable cases, astronomers like

Dark starspots similar to these sunspots apparently can affect a star's spectrum in much the same way as an orbiting planet. Astronomers think starspots may be masquerading as one extrasolar planet. NSO/AURA/NSF



Give a Gift That Lasts the Entire Year!

REVIEW: MEADE'S HOT ETX REFRACTORS
Astronomy
AMERICA'S BEST-SELLING ASTRONOMY MAGAZINE
Peering into Black Holes
Which Came First: Stars, Galaxies, or Black Holes?
Astronomers Battle for Telescope Time
Southern Sky Treasures Revealed
BONUS POSTER: THE BEST MILKY WAY IMAGE EVER
Astronomy
AMERICA'S BEST-SELLING ASTRONOMY MAGAZINE
TWIST OF FATE
THE MILKY WAY'S COMING DISASTER
page 38
Predicting a Leonid Meteor Storm
Sky Survey Reveals Hot, New Infrared Photos
First Views of the Dark Age
SPECIAL ISSUE ON COSMOLOGY
Astronomy
AMERICA'S BEST-SELLING ASTRONOMY MAGAZINE
THE ULTIMATE COSMIC MYSTERIES
Divining the Fate of the Universe
The Essential Guide to Buying Binoculars
Atom Boom: Particles Reveal Big Bang Secrets

Astronomy is the ideal gift for all astronomy enthusiasts – from beginners to experts! Each monthly issue includes the latest news, features, and sky events, plus product reviews, observing techniques, dazzling photography, and more! This year, give stargazers a gift they're sure to use and enjoy!

Order Today! It's easy!

Send in the attached card,

or call 800-533-6644 (outside the U.S. call 262-796-8776 ext 661)

or order online at www.astronomy.com

A2CA

to check the Doppler data against other measures, such as changes in the star's brightness. Because HD 192263 is young (young stars tend to rotate rapidly, generating magnetic fields that give rise to spots), both teams who thought they'd found a planet sought out Henry's help to confirm it.

"My photometric measurements show the star's rotation period is 24.5 days, which turns out to be the orbital period of their planet. Therein presents the problem," says Henry. "How do we sort out if what we're seeing is a planet, or spots, or a combination of both?"

One way is to measure the star's brightness and spectral shifts at the same time to see if they overlap. Stephane Udry of the Geneva Observatory and his colleagues in the Swiss planet-hunting team are doing just that.

According to their data, the brightness changes become very erratic after a couple of periods, while the Doppler shifts continue like clockwork, which suggests something more than starspots is at play. "We are convinced they are not from the same origin," he says, though he's not sure what could cause the discrepancy.

Planet hunter Geoff Marcy of the University of California, Berkeley, agrees with Henry. "Greg Henry did beautiful work showing what we half-suspected — that it's spots rather than a planet," he says.

While most extrasolar planets have been found around stars too old to harbor spots, Henry believes his results may become important "as the masses of new planet candidates get smaller and thus the radial velocity variations are very small." — Maggie Mckee

BLACK HOLES

Black Holes Rage in Old Age

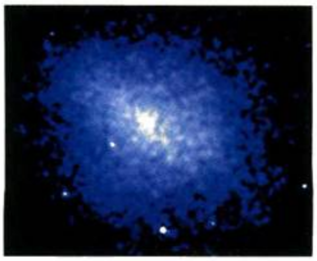
▶ X-ray observations are changing astronomers' attitudes about the "retirement homes" of the universe. Largely populated with old galaxies that have long ceased spawning many new stars, galaxy clusters have been regarded as quiet communities where the majority of residents are no longer very active. But a team of astronomers from the Carnegie Observatories has found many more active galaxies in one cluster than they'd expected to see, challenging our understanding of galaxy cluster evolution.

Optical surveys revealed that only about one percent of galaxies in clusters have active galactic nuclei (AGN), which are driven by matter accreting onto supermassive black holes. So when Paul Martini and his colleagues used the Chandra X-ray Observatory to examine the hundred brightest members of the cluster Abell 2104, they expected to find only one active galaxy. Instead, they found six.

The team then used the 6.5-meter Walter Baade Telescope in Chile to confirm that all the active galaxies were part of the cluster. "This changes our view of galaxy clusters as the retirement homes for old, quiet black holes," Martini says.

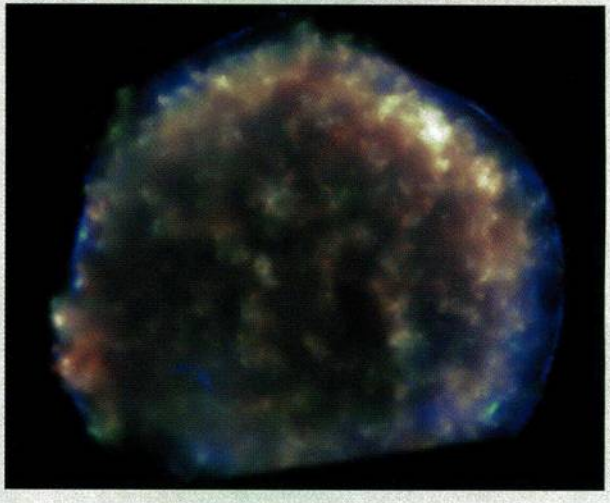
According to theory, black holes emit radiation when they swallow nearby clumps of gas and dust. Astronomers think most cluster galaxies become inactive because they lose this excess material — perhaps by using it up in starbursts triggered by a collision with another galaxy or by being stripped of interstellar material when they join the galactic group. The galaxies would no longer have the resources for producing young, blue stars, or for black hole activity.

"The presence of these AGN indicates that supermassive black holes have somehow retained a fuel



X rays reveal six active galaxies in the relatively staid environment of the galaxy cluster Abell 2104, located some 2 billion light-years from Earth. This recent Chandra result suggests that voracious black holes may be as common in old galaxies as in young ones. NASA/CXC/P. Martini et al.

CHANDRA X-RAY OBSERVATORY



NASA/CXC/SAO

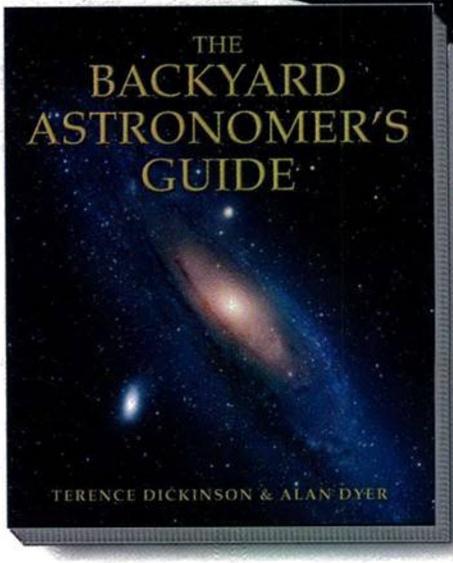
TURBULENT DEBRIS RACES OUTWARD from the site of a supernova witnessed on Earth by Tycho Brahe in 1572. Chandra captured the x-ray energy flooding from the clumps of stellar debris that make up Tycho's supernova remnant. The colors represent different x-ray energies, with red, green, and blue showing low-, medium-, and high-energy x rays, respectively. A shock wave produced by the expanding debris is outlined by the sharp blue circular arcs seen on the outer rim. This gas glows at a temperature of 35 million degrees Fahrenheit, while the stellar debris itself is only about half as hot. Unlike many supernova remnants, Tycho's shows no evidence of a point source at its center. That jibes with other evidence that this was a Type I supernova, in which a white dwarf accumulates too much material and detonates in an explosion that completely destroys the star. That stands in contrast to Type II supernovae, which result when a massive star collapses. These typically leave behind neutron stars, often seen glowing at the remnant's center.

The standard reference for amateur astronomers – in a colorful, revised and updated edition

THE BACKYARD ASTRONOMER'S GUIDE

Second Edition

by Terence Dickinson and Alan Dyer


THE
BACKYARD
ASTRONOMER'S
GUIDE
TERENCE DICKINSON & ALAN DYER

- Big format 9″ x 11″
- 320 pages in full color
- Hundreds of superb photos
- The very latest discoveries
- Advice on buying the most contemporary equipment

$49.95 hardcover

How good are the new computerized telescope mounts?

What type of telescope is best for beginners?

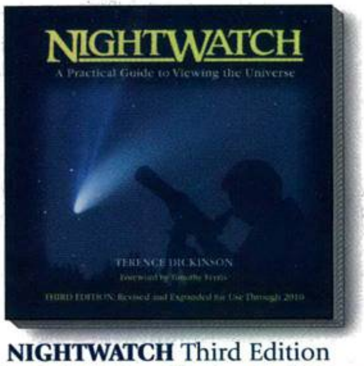
How do I use my new digital camera for astrophotography?

These are just a few of the hundreds of questions – answered clearly and wisely by Dickinson and Dyer in the long-awaited new edition of their classic book.

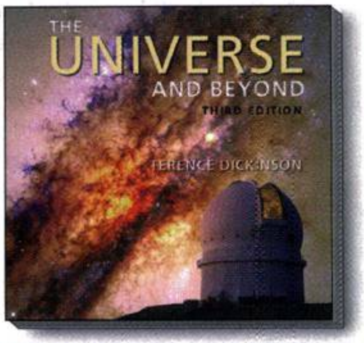
Their elegant, straight forward approach to a complex subject makes this the most user-friendly astronomy book ever published.

THE MOUNT
How the Sky Works
Iridium Flares

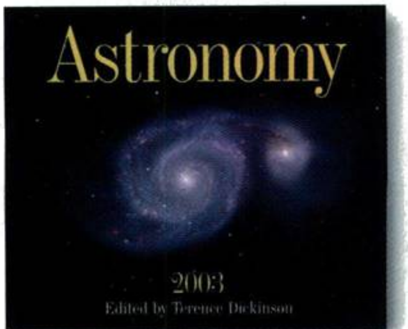
And look for these outstanding publications by Terence Dickinson


NIGHTWATCH
A Practical Guide to Viewing the Universe
TERENCE DICKINSON
Foreword by Timothy Ferris
THIRD EDITION: Revised and Expanded for Use Through 2010

NIGHTWATCH Third Edition
A Practical Guide to Viewing the Universe
176 pages in color
$29.95 spiral-bound hardcover


THE
UNIVERSE
AND BEYOND
THIRD EDITION
TERENCE DICKINSON

THE UNIVERSE AND BEYOND
Third Edition
168 pages in color
$29.95 paperback


Astronomy
2003
Edited by Terence Dickinson

ASTRONOMY 2003 CALENDAR
Big, colorful wall calendar
Lots of useful tips
$12.99

published by FIREFLY BOOKS
3680 Victoria Park Avenue, Toronto, Ontario M2H 3K1
www.fireflybooks.com

At bookstores and telescope centers now

source," says Martini. Galaxies might hold on to their gas and dust better than astronomers thought. This unexpected supply might also be what's preventing optical telescopes from spotting the AGN radiation.

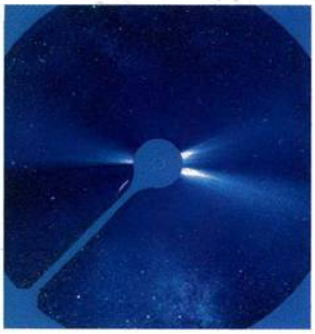
"X rays can penetrate obscuring gas and dust as easily as they penetrate the soft tissue of the human body to look for broken bones," says team member Dan Kelson. "This activity has simply been hidden from us all this time."

The team reported its findings in the September 10 issue of *The Astrophysical Journal*. Martini and his colleagues have already begun examining other galaxy clusters to look for more previously hidden active galactic nuclei. — V. T.

COMETARY SCIENCE

Comets Split Far from Sun

▶ A class of self-destructive comets called sungrazers are giving new meaning to the biblical edict, "Dust thou art, and unto dust thou shalt return." Eccentric drifters that normally roam the farthest reaches of the solar system, these daredevils fly so close to the Sun that they pass through its scorching corona. Now, new research suggests they break apart not only in the intense environment near the Sun, but all along their orbits — lending insight into the stresses that may cause all comets to crack.



A sungrazing comet feels the heat as it plunges into the Sun. Surprisingly, recent observations show that such comets are as likely to break up far from the Sun as they are in close proximity. SOHO/LASCO (ESA and NASA)

A couple of thousand years ago, the gravity of the planets probably shoved a single, large comet into an orbit that grazed the Sun. The Sun's gravity and heat may have ripped it apart and cooked off the ice that held it together, spawning a new generation of sungrazers. Astronomers believed this fragmentation happened again and again. They based this on observations of sungrazers smaller than about a kilometer across that split into pieces near perihelion, the point on their orbits closest to the Sun.

But in a paper in the September 10 issue of *The Astrophysical Journal*, Zdenek Sekanina of NASA's Jet Propulsion Laboratory argues that sungrazers actually come apart throughout their orbits. Examining data from the Solar and Heliospheric Observatory (SOHO), Sekanina noticed that many sungrazers approaching perihelion appear too small to have survived a previous swing by the Sun without breaking up.

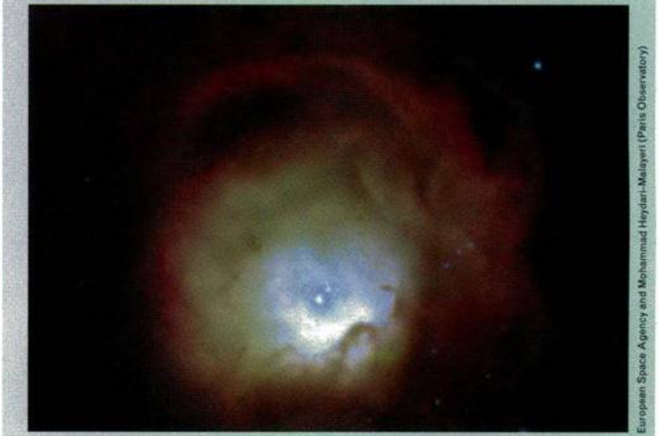
They also arrive in clusters, often reaching the Sun only a few hours apart. Yet if perihelion were the only place where the comets broke up, any tiny difference in the velocities of the newborn pieces would become magnified by the Sun's gravity over the length of their orbits. The pieces would then return to perihelion hundreds of years apart.

"How come we are seeing pieces a fraction of a day apart?" asks Sekanina. "The answer is that we are seeing fragments of comets that split at very large distances from the Sun." Pieces of comets that break apart far from the Sun manage to stay together well, explaining observations of closely spaced clusters of sungrazers.

"Although we don't know for sure what makes them break up," says Sekanina, "I believe one of the causes, if not the only cause, is rotational breakup." Comets spin on their own axes, he says, and "if the spin is greater than the critical value that keeps the body together, they break up."

Recent observations of Comet 57P/du Toit-Neujmin-Delporte illustrate this. Although not a sungrazer, it returned to view in July with a group of 19 smaller fragments. Sekanina believes sungrazers may shed light on the behavior of all comets, and that because more than 450 sungrazers have been spied by SOHO since its launch in 1995, their sheer numbers "provide a wealth of information that is unrivaled." — M. M.

HUBBLE SPACE TELESCOPE



European Space Agency and Mohammad Heydari-Malayeri (Paris Observatory)

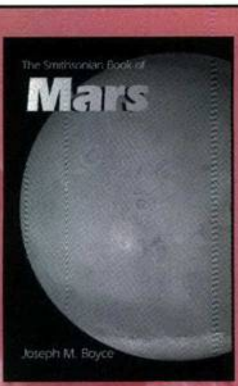
FIERCE RADIATION FROM MASSIVE STARS at the center of this cloud of gas and dust excites the gas to glow like a fluorescent light. The nebula, designated N11A, resides in the Large Magellanic Cloud, a companion galaxy to the Milky Way that lies deep in the southern sky at a distance of about 160,000 light-years. N11A forms just a small part of a vast star-forming region, but it is the most compact of the nebulae there and represents the most recent site of massive star formation. This Hubble image reveals both the structure of the hot gas as well as the stars at its center, seen here for the first time. Shock waves and strong stellar winds from the recently born stars have scooped out a noticeable cavity in the gas and dust. By studying the birth of massive stars in the nearby universe, astronomers hope to better understand how stars formed in the distant, young universe.

The Smithsonian Book of Mars

Joseph M. Boyce

NASA's Mars exploration program scientist presents the most current and comprehensive look at what we know about Mars and how we know it.

42 color, 72 b&w photographs • 288 pp. • Hardcover $37.95


The Smithsonian Book of
Mars
Joseph M. Boyce

We Have Capture

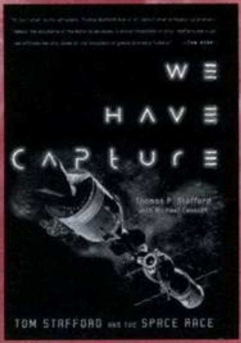
Tom Stafford and the Space Race

Tom Stafford with Michael Cassutt

"As American flight commander of the first ever rendezvous-in-space with the Soviets, Tom Stafford started raising the Iron Curtain. A great talent, a great career—and still involved!"—John Glenn

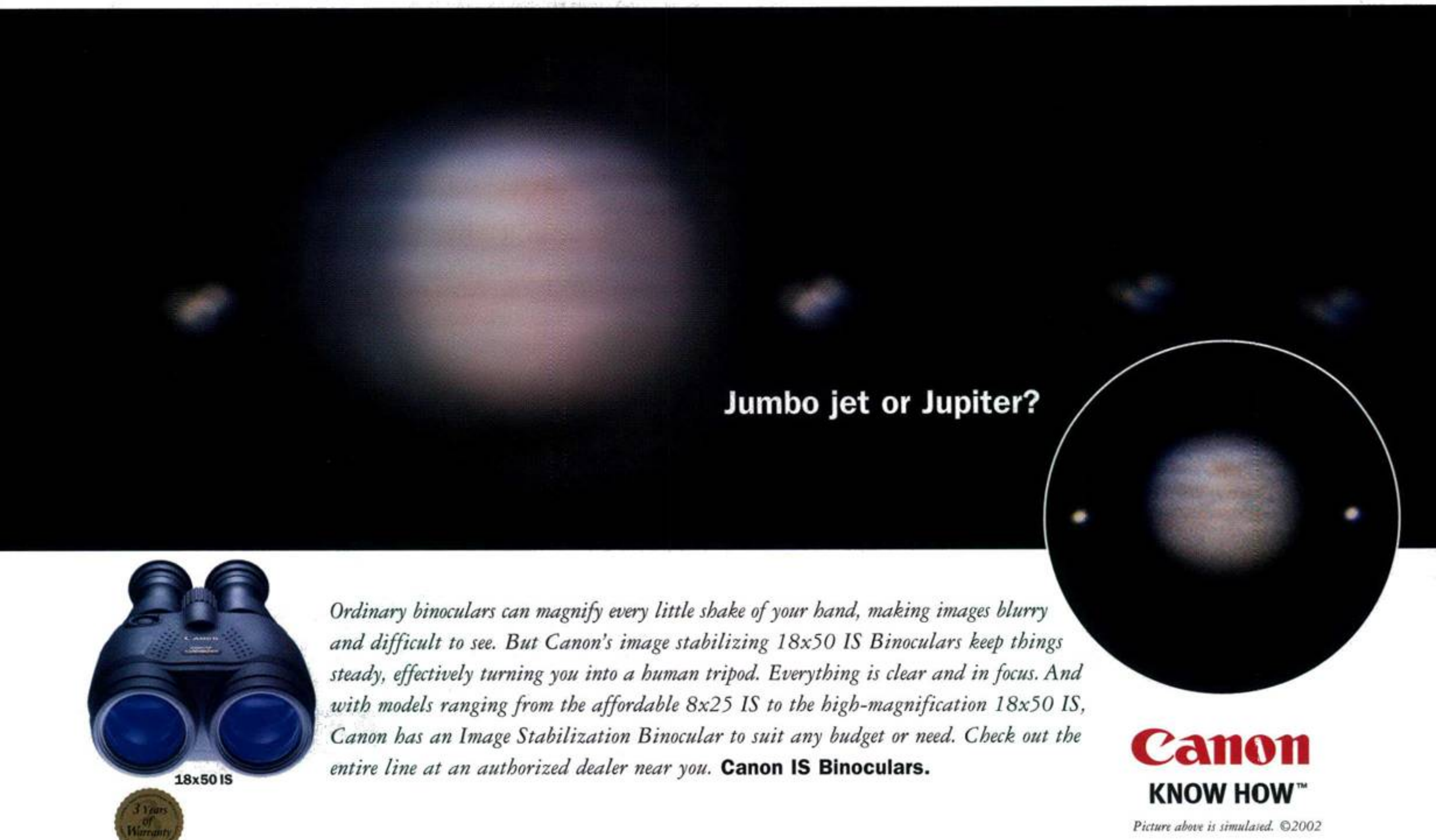
"In his career as an astronaut, Thomas Stafford saw it all: Gene Cernan's fogged up pressure helmet, the mountains of the moon oh-so-close, a Soviet handshake in orbit. Stafford was truly one of those few who stood on the shoulders of giants and made history." —Tom Hanks

30 b&w photographs • 224 pp. • Hardcover $29.95


WE
HAVE
CAPTURE
Thomas P. Stafford
with Michael Cassutt
TOM STAFFORD AND THE SPACE RACE

Smithsonian Institution Press

800.782.4612 • www.sipress.si.edu


Jumbo jet or Jupiter?
18x50 IS
3 Years of Warranty
LIMITED WARRANTY
Canon
KNOW HOW™

Ordinary binoculars can magnify every little shake of your hand, making images blurry and difficult to see. But Canon's image stabilizing 18x50 IS Binoculars keep things steady, effectively turning you into a human tripod. Everything is clear and in focus. And with models ranging from the affordable 8x25 IS to the high-magnification 18x50 IS, Canon has an Image Stabilization Binocular to suit any budget or need. Check out the entire line at an authorized dealer near you. **Canon IS Binoculars.**

Picture above is simulated. ©2002

*Canon U.S.A. Inc. Canon is a registered trademark and Canon Know How is a trademark of Canon Inc. Visit us at **www.usa.canon.com** or call 1-800-OK-CANON.*

BROWN DWARFS

First Forecast: Cloudy; No Rain

Astronomers have seen planet-like weather on brown dwarfs, marking the first time such weather has been observed on objects outside the solar system. Brown dwarfs fall in the gap between giant planets and stars. Unlike stars, they have too little mass to ignite hydrogen fusion in their cores, so they glow dimly and emit most of their radiation in the infrared.

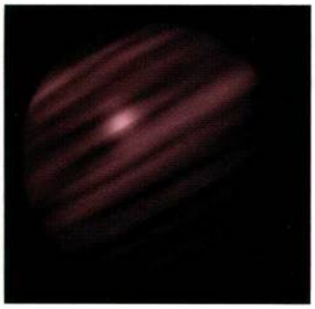
"The best analogy to what we witness on these objects are the storm patterns on Jupiter," says Adam Burgasser of UCLA, who led one of several research teams. "But I suspect the weather on these more massive brown dwarfs makes the Great Red Spot look like a small squall." The Red Spot spans some 15,000 miles and has winds that blow 270 miles per hour.

Burgasser's team developed a model that explains puzzling observations of brown dwarfs briefly growing brighter as they cool. The model shows that as they cool, their atmospheric gases — made up of iron, sand, and other substances — condense into liquid droplets to form clouds. Storms then whisk away the clouds and reveal the hotter atmosphere beneath the clouds, causing the brown dwarf to brighten. The team reported its results in the June 1 issue of *The Astrophysical Journal Letters.*

A separate team from the University of Montreal in Canada has been monitoring the infrared glow of brown dwarfs. At the May 2002 meeting of the International Astronomical Union in Hawaii, the astronomers reported variations in energy output that they believe were caused by cloud motion or temperature changes similar to the dark spots on the Sun.

Another team, called CLOUDS for Continuous Longitude Observations of Ultra-cool Dwarfs, has seen similar results. "We confirm the variability detected by our Canadian colleagues," says Eduardo Martín of the University of Hawaii. "These objects are so cool and magnetically inactive that weather patterns are a plausible explanation."

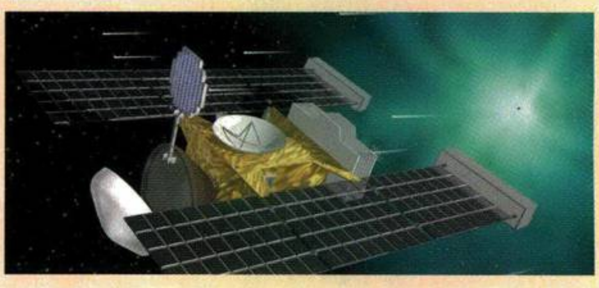
Brown dwarfs will help scientists learn how to interpret observations of planet-like objects around other stars, says Mark Marley of Burgasser's team. "Everybody wants to find brown dwarfs that have water clouds," he adds. "Once we find those, that will be a good test of our understanding." — R. T.



Recent studies show that cloudy weather reigns in the atmospheres of brown dwarfs. This artist's concept shows what the cloud bands on a typical brown dwarf might look like.

Douglas Pierce-Price, Joint Astronomy Centre

For the latest astronomy news as it breaks, visit us at www.astronomy.com



Stardust has begun collecting interstellar dust grains. NASA/JPL

Stardust Starts Collecting Dust

For the second time since its launch nearly four years ago, the Stardust spacecraft is gathering tiny grains of interstellar dust that flow into the solar system. The collecting phase began on August 5 and runs until December 9. Stardust uses a special formulation of aerogel, the world's lightest solid, to capture the particles. The spacecraft will fly past Comet Wild 2 in January 2004 and return the dust and comet samples to Earth two years later.

A Fourth Flavor of Neutrino?

The initial phase of the Booster Neutrino Experiment at Fermilab in Batavia, Illinois, recorded its first neutrinos in September. The neutrinos created flashes of light inside a 250,000-gallon detector filled with mineral oil. The experiment seeks to confirm or refute a 1995 experiment that found a few neutrino oscillations, which imply that these ubiquitous subatomic particles have mass. "Confirming the result would suggest the existence of an additional kind of neutrino beyond the three known types," says physicist Janet Conrad of Columbia University, "and would require physicists to rewrite a large part of the theoretical framework called the Standard Model."

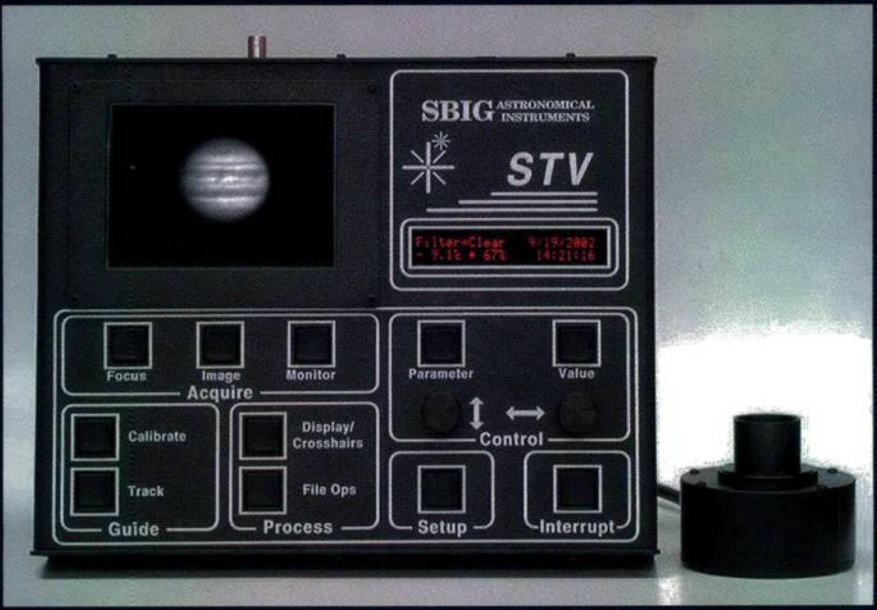
Glimpse into a Dying Star

Two long outflows with thread-like structures and tattered ends highlight a recent Hubble image of planetary nebula Henize 3–401. The image shows for the first time the central, dying star, which puffed off its outer layers to create the nebula. Although many planetaries show a similar elongated, or "bipolar," structure, astronomers disagree on how it forms. Some think a companion star can create the jet-like streamers of gas, while others believe strong magnetic fields funnel the gas into long outflows.

Henize 3–401 is one of the most elongated planetary nebulae yet found. European Space Agency and Pedro García-Lario (ESA ISO Data Centre)

SBIG
ASTRONOMICAL
INSTRUMENTS

THE REVOLUTIONARY STV


SBIG ASTRONOMICAL INSTRUMENTS
STV
Filter=Clear 9/19/2002
- 9.1s * 67% 14:21:16
Focus
Image
Monitor
Acquire
Parameter
Value
Control
Calibrate
Track
Guide
Display/
Crosshairs
File Ops
Process
Setup
Interrupt

The First STAND ALONE DIGITAL INTEGRATING *VIDEO* CAMERA AND AUTOGUIDER

NOW SUPPORTS A COLOR FILTER WHEEL OPTION FOR TRI-COLOR OR QUAD COLOR IMAGING

LIKE NO OTHER ASTRO CAMERA OR AUTOGUIDER IN THE WORLD

- ◆EASY TO USE, PORTABLE - **NO COMPUTER REQUIRED**
- ◆VIEW THE MOON, PLANETS **AND** DEEP SPACE OBJECTS ON ANY VIDEO MONITOR OR ON THE OPTIONAL BUILT-IN 5" LCD DISPLAY
- ◆RECORD VIDEO IMAGES ON ANY VCR ▶ NO FRAME GRABBER REQUIRED
- ◆STORE DIGITAL IMAGES IN THE STV's INTERNAL MEMORY FOR DIRECT DOWNLOAD TO A COMPUTER AT A LATER TIME
- ◆OPERATES AS A STAND ALONE AUTOGUIDER, 30 TIMES MORE SENSITIVE THAN AN ST-4
- ◆REACH 14th MAGNITUDE IN ONE SECOND (18th MAGNITUDE IN ONE MINUTE) THROUGH AN 8" SCOPE

SBIG
ASTRONOMICAL
INSTRUMENTS

SANTA BARBARA INSTRUMENT GROUP
147-A Castilian Dr.
Santa Barbara, CA 93117
Phone (805) 571-7244 FAX (805) 571-1147
e-mail: sbig@sbig.com Home page: www.sbig.com

NEW!
****
IMPROVED
AUTOGUIDING
FEATURES AND
SUPPORT FOR CFW5
COLOR FILTER WHEEL

Do You Believe in the Big Bang?

Just one in three Americans believes the universe was created in a cosmic explosion. Here are five reasons why everyone should.

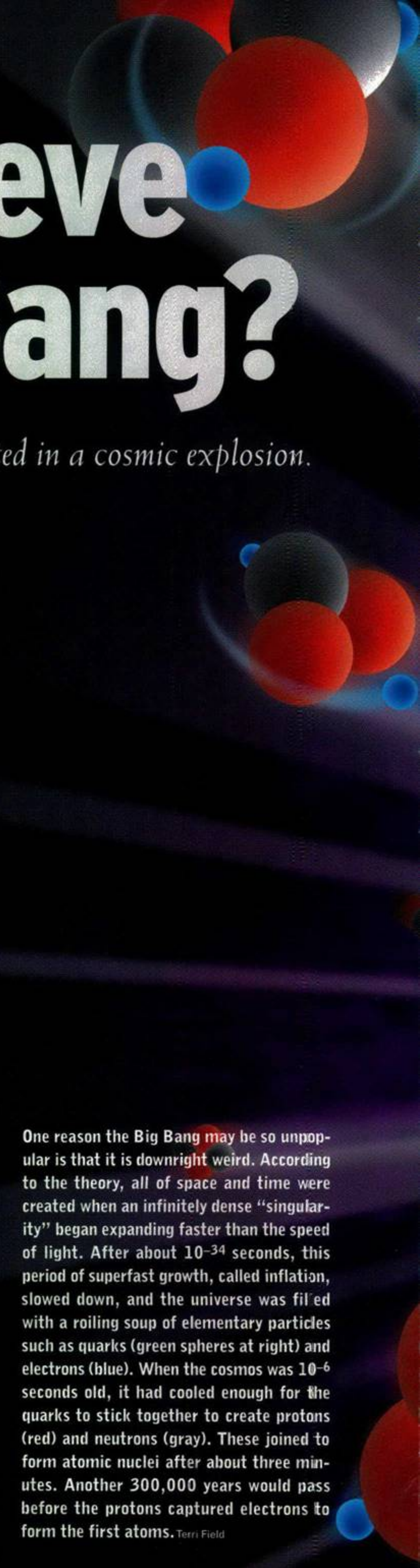
by Jim Sweitzer

One of the joys of having worked in a science museum is getting to see people's reactions to exhibits, the most gratifying being the sudden "a-ha" of recognition that accompanies a concept freshly understood. As director of astrophysics education at the Rose Center for Earth and Space in New York's American Museum of Natural History, I saw a lot of those lightbulb moments. But the response from one particular exhibit never failed to amaze me. After walking down a 300-foot spiral pathway lined with the biography of the universe, a tale that begins with the Big Bang, many visitors remain dubious. "How do scientists *know* there was a Big Bang?" they ask. "Isn't it just one theory among many?"

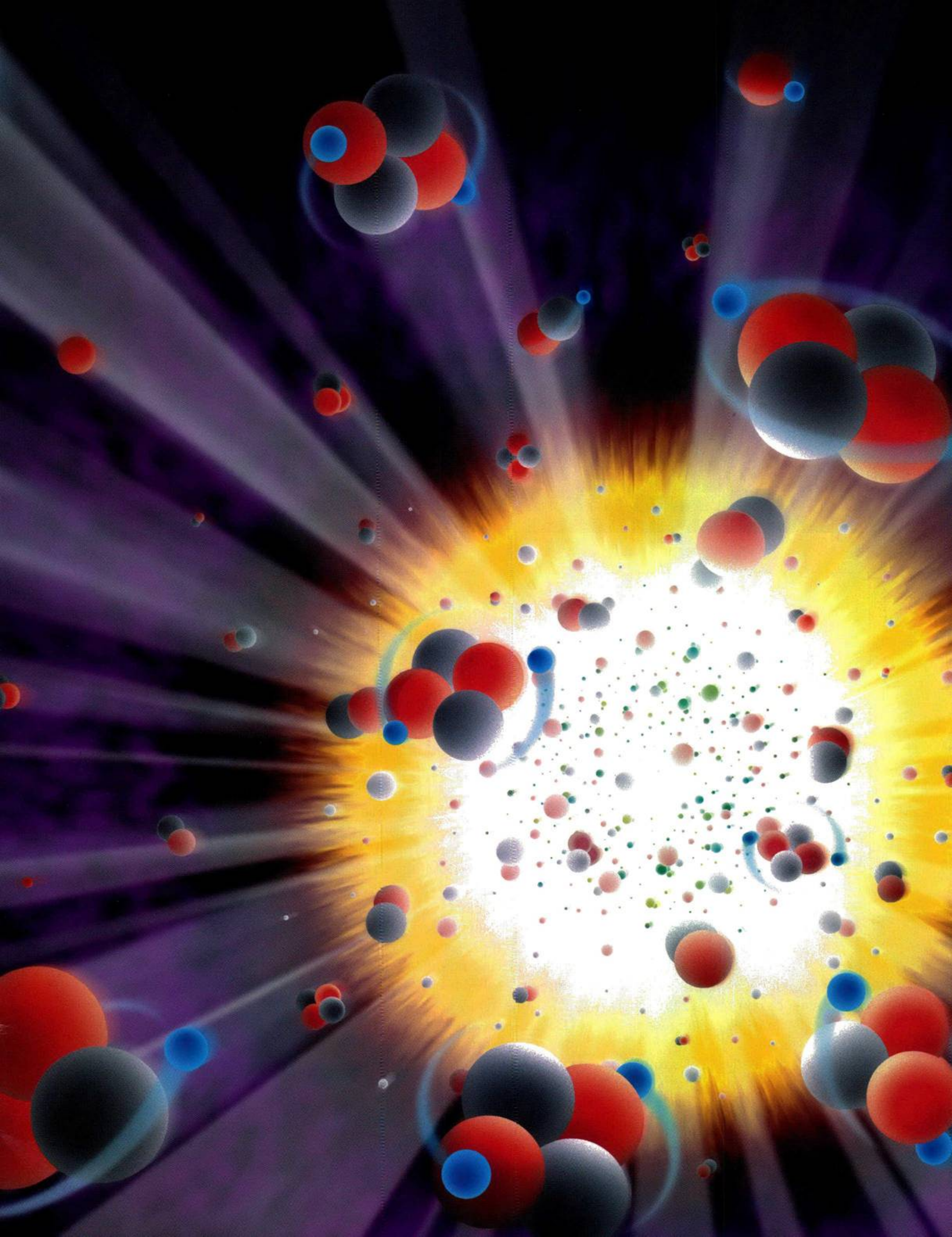
These questions are somewhat shocking to me, as an astrophysicist. As theories go, the Big Bang ranks close to Copernicus's notion – now accepted as unshakeable fact – that the Sun, not Earth, is the center of the solar system (an idea once so scandalous that one of its proponents, Galileo, was forced into house arrest).

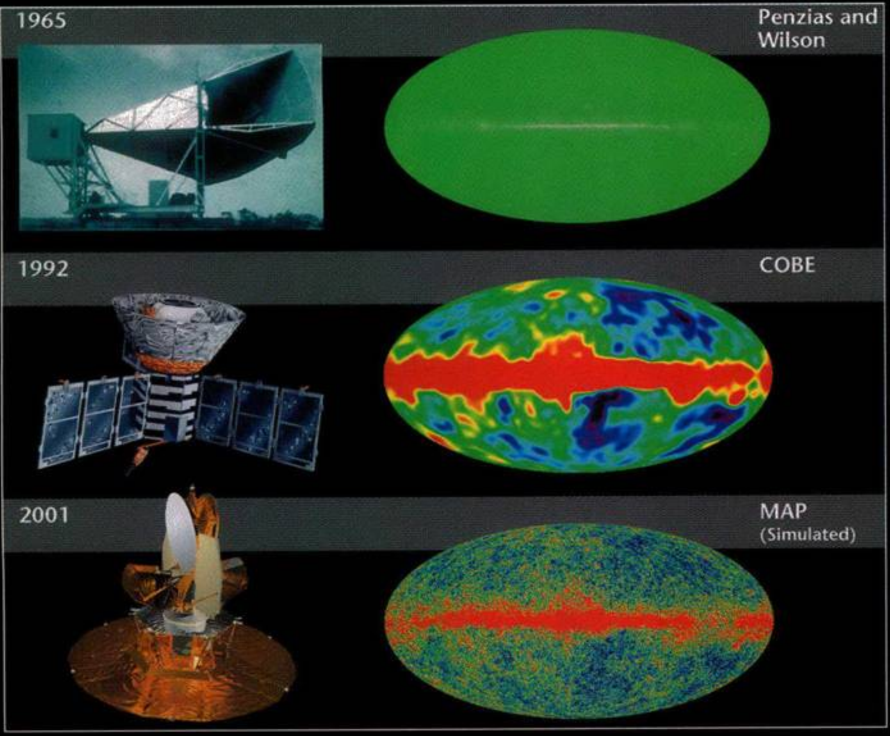
Yet popular belief in the Big Bang has not taken hold. The National Science Foundation's surveys of the public understanding of science have consistently shown that although about 70 percent of American adults believe in the Copernican theory, only 33 percent accept the Big Bang. That's actually five-percent *fewer* people than before the 1990s, and smaller still than the number of supporters of evolution (53 percent), a subject steeped in controversy in recent years.

These numbers make some sense when you consider how far-fetched – not to mention how far removed – the Big Bang can seem. We're asked to swallow some mind-bending concepts: that everything, including space and time, was created in one instant (it's anyone's speculation what came before that). The fact that all of this took place billions of years ago, when no one was looking, makes it even more suspect, as does its designation as a "theory," which in nonscientific terms means more like "guess." Indeed, when the idea was first proposed, it struck English cosmologist Fred Hoyle



One reason the Big Bang may be so unpopular is that it is downright weird. According to the theory, all of space and time were created when an infinitely dense "singularity" began expanding faster than the speed of light. After about 10^{-34} seconds, this period of superfast growth, called inflation, slowed down, and the universe was filled with a roiling soup of elementary particles such as quarks (green spheres at right) and electrons (blue). When the cosmos was 10^{-6} seconds old, it had cooled enough for the quarks to stick together to create protons (red) and neutrons (gray). These joined to form atomic nuclei after about three minutes. Another 300,000 years would pass before the protons captured electrons to form the first atoms. Terri Field





When the universe had cooled enough to form atoms (about 300,000 years after the Big Bang), light from the primordial fireball was able to escape and fill all of space. Over the next 14 billion years, it cooled to just a few degrees above absolute zero, in the microwave-range of radiation. In 1965, astronomers Arno Penzias and Robert Wilson accidentally stumbled across this radiation, and their snapshot of the early universe boosted the Big Bang's strength as a theory. In 1992, NASA's Cosmic Background Explorer (COBE) satellite took an even better picture of this cosmic microwave background (CMB) radiation. The colors represent very slight temperature variations. Warmer regions are thought to have developed into structures such as galaxies, and cooler spots probably emptied out into voids. In 2001, the Microwave Anisotropy Probe (MAP) mission was launched to measure the CMB in finer detail. The illustration at left shows what the first data, to be released in January 2003, might look like. To learn more about the CMB and recent results from these investigations, visit the *Astronomy* magazine page at *Astronomy.com.* NASA/GSFC

as so ridiculous that he dubbed it the "Big Bang" mockingly; nevertheless, the name stuck.

Improbable though it may seem, the concept of a primordial blast is based on many lines of evidence that are strengthened with each new observation. And while there were no eyewitnesses to the explosion, the shrapnel is all around us. Some traces are easy to see and others can be glimpsed only with telescopes and spectroscopes. The very atoms in our bodies are the products of the development of our cosmos from a hot, compact beginning.

The crucial moment

Everything in our observable universe — all the matter and energy we detect today with our most powerful telescopes — was once concentrated into a tiny region of unimaginable density.

Some 14 billion years ago, this tiny region began expanding faster than the speed of light in a period known as inflation (this may seem like a loophole in Einstein's special theory of relativity, where he says that nothing can move faster than light — in this scenario, space itself, not a physical object, is breaking the cosmic speed limit).

In a millionth of a second, subatomic particles called quarks coalesced to form protons and neutrons. These newborns

"Just" a Theory?

All roads of evidence lead to the Big Bang, which was constructed to explain the evolution of the universe in time. No other theory even comes close, yet still people ask, "Isn't it just a theory?"

A simple issue of semantics may be the culprit — the term theory means something very different to scientists and non-scientists. To scientists, facts, hypotheses, and theoretical models — or theories — have precise meanings and carry different intellectual weights.

Facts derive from observational data, but they don't usually tell complete stories. For that you need theories, which are built from facts and successful hypotheses (educated guesses or conjectures that show promise) to explain phenomena in the universe.

Until the early 1960s, the Big Bang was just a hypothesis. When the cosmic microwave background (CMB) was discovered in 1965 and subsequently verified, the Big Bang hypothesis became a bona fide theoretical model.

Scientific models are useful because they make testable predictions of physical phenomena. The Big Bang passed a critical test when researchers used it to successfully predict the abundance of the lightest elements.

The real worth of the theory lies in its ability to act as a kind of cosmic clock whose hands point to temperature and density rather than hours and minutes. When one runs this imaginary clock backward in time or, equivalently, looks deeper into space, the Big Bang model predicts these vital quantities. From them, one can then infer the state of the universe at any given time.

Because scientists use it to pose more refined questions that they can test, the Big Bang theory is more dynamic explanation than calcified dogma. It will surely grow as astronomers make deeper and more subtle observations. — *J. S.*

Evidence for the Big Bang is all around us. The very darkness of night suggests the universe had a beginning in time. Edwin Hubble viewed galaxies near the constellation Pegasus, above, to prove that the universe is expanding. Dewey Vanderhoff

then flash-fused into the simplest atomic nuclei — in the time it takes to cook a bag of microwave popcorn.

Slowly, the cosmic furnace cooled. Electrons joined forces with the nuclei to create the first atoms about 300,000 years after the Big Bang. This cleared a fog of free particles that until then had prevented light from traversing space.

Within a few hundred million years, clouds of matter fragmented to form the first stars. And as the universe evolved into billions of galaxies full of billions of stars, in one galaxy called the Milky Way, a rather average star was born nine billion years after the birth of the cosmos. As we now know from Copernicus, it is this star, the Sun, around which our planet orbits.

The case for the Big Bang

The saga of the Big Bang is the scientific origin story for all of modern astrophysics and the language by which astronomers explain nearly all they see with their telescopes. It is to an astronomer what evolution is to a biologist — and even more unpopular with the public. So, ladies and gentlemen of the jury, if you're on the fence about the theory, read on — the following five exhibits will prove beyond a reasonable doubt that the universe was created in the Big Bang.

Exhibit A: The night sky

The darkness of night is mute witness to the fact that our universe had a beginning in time billions of years ago. The argument resolves what is known as Olber's Paradox, which goes like this: If the universe were infinitely old and infinitely big, as some once believed, then every line of sight heavenward would intersect a distant stellar surface and the entire sky would be as bright as the surface of our Sun. This, obviously, is not the case — night invariably follows day.

One way to account for dark nights is that the universe had a birth in time, so we can only see as many stars as have formed since then. Although this alone cannot prove the Big Bang, it prefigured four lines of evidence, discovered in the 20th century, for a dense, hot cosmic beginning.

Exhibit B: The expanding universe

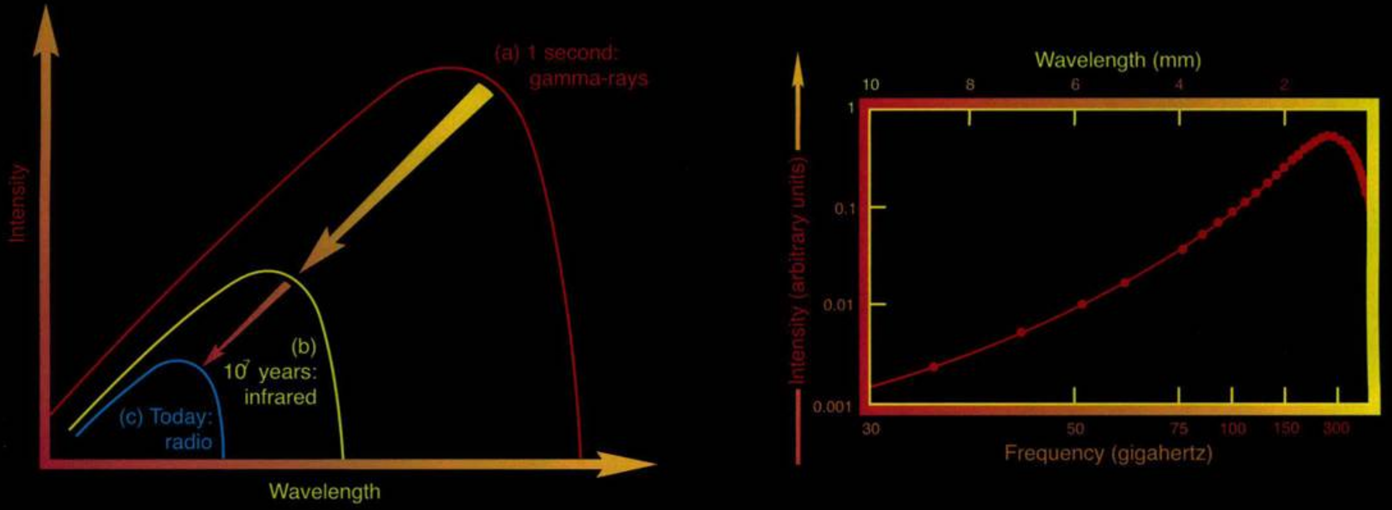
On a clear, star-filled autumn night in the Northern Hemisphere, the distinctive square of the constellation Pegasus beckons like a celestial baseball diamond. In center field, the galaxy M31 shines with the collective light of billions of stars. This light left M31 two million years ago, when *Homo habilis*, the earliest species of our genus *Homo*, fashioned Earth's first stone tools. This is the galaxy the virtuosic astronomer Edwin Hubble scrutinized with his tool, the 100-inch Hooker telescope atop Mount Wilson.

In the 1920s, Hubble proved that M31 and other similar smears of light were vast islands of stars akin to our own Milky Way Galaxy. Subsequently, he noticed that more distant galaxies are receding faster than those nearby — an observation that could be explained if the universe were expanding. (Picture a rising loaf of raisin bread — if the raisins are galaxies, an observer on one raisin would see other raisins flying away, with more distant ones receding faster as the space between them expands).

This was the first indication that our universe is expanding and was denser in the past. Observations at the time were insufficient to convince astronomers that the early universe was hot and uniform — that would come decades later, and quite by accident.

Exhibit C: Background radiation

Walk outside at any hour and open a palm to the sky. An imperceptible mist of two-millimeter-wavelength photons will



Left: Objects at a single temperature, such as the universe just after the Big Bang, emit radiation in a predictable way. When the intensity of the light at each wavelength is plotted, you get a graph that looks like a camel's hump called a thermal spectrum. These spectra represent what the Big Bang theory predicts the cosmic microwave background (CMB) looked like (a) one second after the Big Bang, (b) 10 million years afterward, and (c) today. Notice that the radiation becomes more feeble (in intensity and wavelength) as time progresses.

Right: The CMB radiation is one of the strongest lines of evidence for the Big Bang. The red curve represents the thermal spectrum predicted by the Big Bang theory, and the dots represent actual measurements of the radiation by NASA's COBE satellite. Theory and experiment hardly ever agree this well in science. *Astronomy*: Jay Smith

strike your hand at the rate of a million billion per second. So weak you can't feel them, they weren't discovered until 1965, when a highly sensitive radio telescope developed at Bell Labs in New Jersey picked up unexplained noise from every direction in the sky.

Scientists soon realized this noise fit the profile of radiation that had been predicted to permeate space about 300,000 years after the Big Bang, when the formation of the first atoms allowed photons to travel relatively unhindered.

When the universe was very young, it was so hot that photons continuously bumped into particles. This kept everything at the same energy and temperature, conditions that leave behind a so-called thermal spectrum of light (see diagrams above). As the universe expanded, this radiation stretched and cooled, retaining its spectral shape but representing ever lower temperatures.

By the time it reached our telescopes in 1965, the temperature of this light, once a primordial fireball, had dropped to about three degrees Celsius above absolute zero.

After the significance of the find — the first possible snapshot of the universe — had sunk in, the two discoverers of the noise, Arno Penzias and Robert Wilson, won the Nobel Prize in physics in 1978. Called the cosmic microwave background (CMB), this radiation first convinced astrophysicists that the Big Bang was a fact of nature.

In the early 1990s, the Big Bang spectrum was measured to unprecedented accuracy by NASA's Cosmic Background Explorer (COBE) satellite to be exactly thermal at a temperature of 2.73 kelvins. In January, astronomers expect to reveal to the public the first data from the latest NASA mission to explore the microwave background, the Microwave Anisotropy Probe (MAP), launched in 2001.

Strengthening the line of evidence even more, it turns out that astronomers can observe the CMB at cosmic distances, as well. Two years ago, researchers using the Paranal Observatory in Chile studied distant intergalactic clouds and showed that the CMB was hotter in the past when the universe was more compact, by the amount Big Bang theorists had predicted.

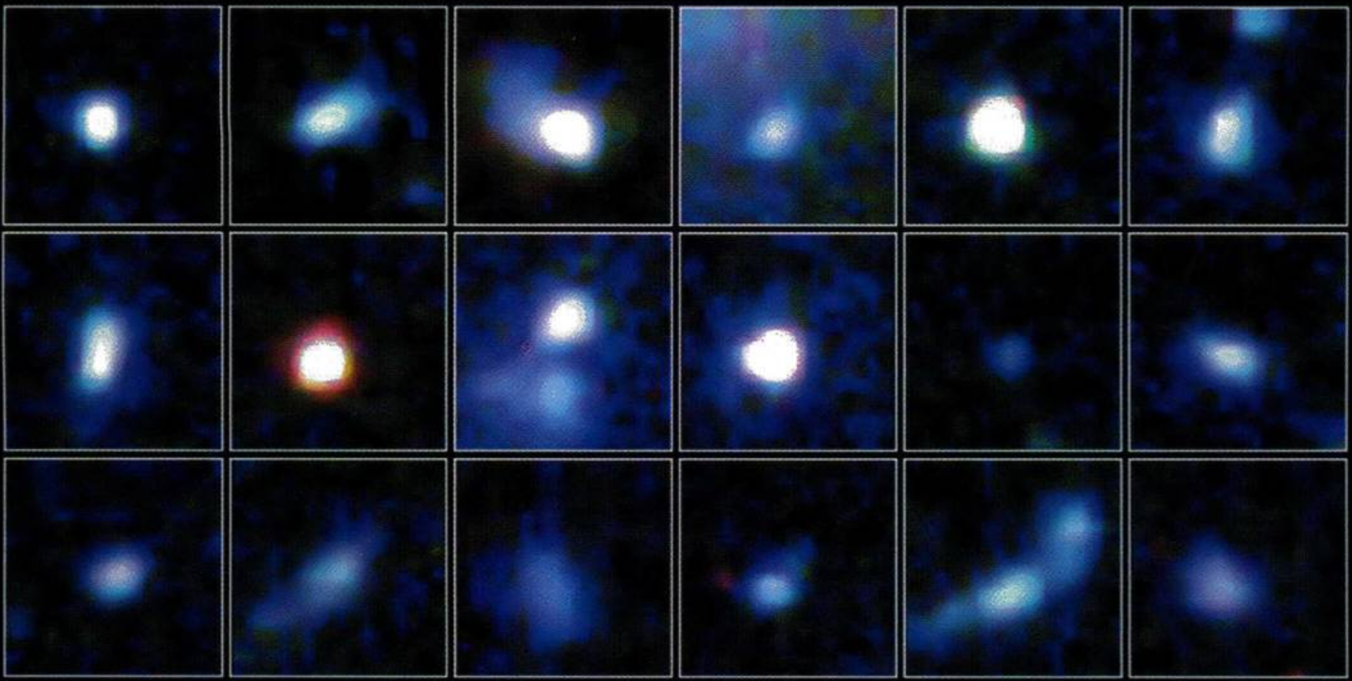
Exhibit D: The light elements

The Sun floods us with more than four hundred billion times as much energy as the CMB, providing the life-sustaining heat that nurtured Earth's breathtaking biodiversity. Yet if the Big Bang had created a different amount of the light element helium, the Sun would not shine the same way.

Extrapolating the rate of galactic expansion back to when the CMB was more energetic (x rays), we can estimate the conditions under which the lightest atomic nuclei flash-cooked. The fusion was fast, only a few minutes long, but it resulted in 25 percent of the mass of protons and neutrons being turned into helium. This is important because the energy output of a star is directly related to the amount of elements such as helium that mix with the main ingredient, hydrogen. (Hydrogen fusion is how most stars derive their energy, but the amount of helium affects the pressure inside the star.)

If the Big Bang had proceeded much slower than predicted, then all the protons and neutrons would have fused into helium and there would be no hydrogen to burn in stars. Alternatively, if the Big Bang had proceeded faster, then the smaller amount of helium would have resulted in a cooler star. Either way, life would have looked a lot different, if it would have existed at all.

Although stars account for nearly all of the elements heavier than helium, they cannot make the lightest ones the way the Big Bang did. The prediction of the exact abundances of the light elements has been confirmed both close to our solar system and deep in space. This, together with the expansion of space and the CMB, clinched the Big Bang theory.



Hidden in a Hubble image were these clouds of gas and stars — thought to be ancient protogalaxies 11 billion years ago. Galactic evolution supports the Big Bang thesis that the universe, once a sea of particles and energy, has become more structured. Rogier Windhorst and Sam Pascarelle (ASU) and NASA

Exhibit E: Evolution of stars, galaxies, and clusters of galaxies

Still, there's yet another line of evidence that supports the Big Bang theory. Just as the fossil record on Earth shows more primitive life forms the deeper one digs in time, so too does the astronomical universe reveal more primitive stars and galaxies the farther out we look. Since light travels at a finite speed, when our telescopes peer deeper into space we are witnessing earlier cosmic epochs.

The Hubble Space Telescope made one of the deepest "excavations" in a region just off the handle of the Big Dipper. Called the Hubble Deep Field, the incredibly far-sighted image has solved a long-standing mystery involving tiny, indistinct blue smudges glimpsed by earlier Earth-based telescopes.

Hubble's acute optics revealed them to be mini-galaxies with blazingly hot new stars. Their number, density, and shape indicate they are the primordial building blocks for the mature, evolved galaxies we see much closer to home. These images stretch back 11 billion years and fill in critical gaps in our understanding of the evolutionary history of galaxies, from early, energetic galactic villages to the stately urban spirals and giant ellipticals of today.

The stars within galaxies have evolved, too. Stars contained far fewer heavy elements in the distant past, which makes sense in light of the Big Bang, which posits that only hydrogen, helium, and a smattering of lithium first populated the universe. Recent results from Hubble indicate that the birth rate of stars long ago was much higher than it is today. These stellar changes compliment the evidence of galactic evolution to unveil a universe that is steadily changing over time, just as the Big Bang predicts.

Unanswered questions

The Big Bang theory is very successful at explaining the gross facts of the universe, but for today's astronomers it is just a platform for a new round of more refined interrogations. Astronomers continue to narrow the field for the critical "parameters" of the universe, including the densities of the various forms of matter and the details of a very early epoch of the Big Bang called inflation.

In the last few decades, astronomers have learned that protons and neutrons, the type of matter both we and the stars are made of, appear to be like tiny nuggets of precious metal distilled from the crucible of the universe. The vast majority of matter seems to be "dark," and doesn't absorb or reflect light, but gravitationally affects its surroundings.

To add insult to injury, some 65 percent of the energy in the universe must also be "dark," coming from neither radiation nor matter. That's the surprising conclusion astronomers reached in 1998, when they spotted distant supernovae even farther away than expected. They realized then the universe was not only expanding — it was *accelerating*.

The Microwave Anisotropy Probe, because it extends our cosmically inadequate senses, will provide some answers; but it will take other special telescopes and detectors to yield a detailed story of how the universe began. If we're lucky, within a decade we might have that evolutionary model. Maybe then more than a third of American adults will believe in the Big Bang.

Yet no concept should be considered inviolable. If there's anything science has shown us, it's that as we probe deeper and ask more sophisticated questions, the answers invariably yield more questions. Although the power of science and technology are great, we've only been at it a short while, merely hundreds of years. The universe has been using physics hundreds of millions of times longer than we have. We still have some catching up to do.

Astrophysicist Jim Sweitzer is the director of the Space Science Center at DePaul University in Chicago.

ORION
TELESCOPES & BINOCULARS

Hundreds more products online!
telescope.com

TELESCOPES

The New Orion SkyQuest™ XT Dobsonian Telescopes
The Best Get Even Better With New Features and Lower Prices

Our popular SkyQuest XT's just got even better with new features such as upgraded Sirius Plössl eyepieces and navigation knobs. Yet they still have the same great performance.

SkyQuest XT4.5
Just the right size for younger stargazers, and incredibly easy to master! Adults will love it too, for its portability and crisp optical performance.

Steel tube, 114mm center marked mirror (f.l. 910mm, f/8), 1.25" aluminum R&P focuser, 5" flanged altitude hubs, CorrecTension Friction Optimization, built in handle, dust cap, Weight: 17.2 lbs. (tube and base). Now With: 6x26 correct-image finder scope, 25mm (36x) and 10mm (91x) Sirius Plössl eyepieces, navigation knob, eyepiece rack, and collimation cap.

$199

SkyQuest XT6
The overachieving XT6 will show Jupiter's Red Spot, Saturn's Cassini Division, hundreds of clusters and nebulas, and galaxies tens of millions of light-years distant. Nicely portable and very affordable

Steel tube, 150mm center marked parabolic mirror (f.l. 1200mm, f/8), 1.25" aluminum R&P focuser, 6x30 achromatic finder scope, eyepiece rack, navigation knob, 5" flanged altitude hubs, CorrecTension Friction Optimization, dust cap, Weight:38 lbs. Now with: 25mm (48x) and 10mm (120x) Sirius Plössl eyepieces (1.25"), navigation knob, and collimation cap.

***New Low Price!* $329**

SkyQuest XT8
The XT8's prodigious performance on both solar system and deep-sky denizens have made it the telescope of choice for thousands of astronomers, from beginners to die-hard hobbyists.

Steel Tube, 203mm center marked parabolic mirror (f.l. 1200mm, f/5.9), 6x30 achromatic finder scope, eyepiece rack, 5" flanged altitude hubs, CorrecTension Friction Optimization, dust cap, Weight: 43 lbs. Now with: 2" aluminum R&P focuser, 25mm (48x) and 10mm (120x) Sirius Plössl eyepieces (1.25"), navigation knob and collimation cap.

***New Low Price!* $449**

NOW WITH PYREX MIRROR!

SkyQuest XT10
Gulping in over 50% more light than an 8" scope, the XT10 reaches far deeper into space. The sheer number of objects visible in this scope is staggering, and its resolving power brings out detail that will keep you entranced for years.

Steel tube, 254mm Pyrex parabolic mirror (f.l 1250mm, f/4.9), 2" aluminum R&P focuser, 9x50 achromatic finder scope, 25mm and 10mm Sirius Plössl eyepieces (1.25"), eyepiece rack, 5" altitude hubs, CorrecTension Friction Optimization, dust cap, navigation knob, collimation cap, Weight: 54 lbs.

***New Low Price!* $599**

New!

SkyView Pro™

Our new top-of-the-line-mount with four different optical tubes to choose from. Solid and stable, with great optics and accessories. The stalwart SkyView Pro features enclosed 360° worm gears and steel tube tripod legs.

Special Offer!

Order now and receive a FREE TrueTrack™ single axis drive or save $70 off a TrueTrack™ dual-axis drive.

SkyView Pro 6
A Professional-quality 6" reflector that's a cut above the average reflector telescope. The SkyView Pro 6 features a 150mm (f/5) center-marked parabolic primary mirror that is just right for targeting a wide-range of objects. Includes 6x30 finder scope, two 1.25" Sirius Pössl eyepieces (25mm and 10mm), collimation cap and dust-cap.

SVP 6 & FREE drive **$489**

SkyView Pro 8
Finally, a telescope that gives views that will blow you away without blowing your budget! A full 8" (203mm, f/4.9) parabolic primary mirror, which gathers 73% more light than a 6". The tube features a 2" aluminum rack-and-pinion focuser and a sturdy 4-vane holder. Includes 6x30 finder scope, two 1.25" Sirius Plössl eyepieces (25mm and 10mm), collimation cap and dust-cap.

SVP 8 & FREE drive **$579**

SkyView Pro 100
Intrepid beginners and advanced amateurs seeking the gathering faculties of a big refractor on a rock-steady mount should take a look at our SkyView Pro 100. The 100mm, 600mm focal length (f/6), fully multi-coated achromatic objective lens finds a perfect niche to fill with detailed planetary views as well as excellent wide-field viewing. Includes 6x30 finder scope, two 1.25" Sirius Plössl eyepieces (25mm and 10mm), 90° star diagonal, collimation tool and dust-cap.

SVP 100 & FREE drive **$499**

SkyView Pro 120
Love refractors? We've combined our 120mm achromatic refractor with our super-sturdy SkyView Pro mount. The big fully multi-coated 120mm (f/8.3) objective lens and 2" focuser will give you jaw-dropping views of the skies. Includes 6x30 finder scope, two 1.25" Sirius Plössl eyepieces (25mm and 10mm), 90° star diagonal, collimation tool and dust-cap.

SVP 120 & FREE drive **$599**

StarMax™ EQ Compact "Mak" Telescopes

The Orion StarMax series brings top-quality Maksutov designs to the amatuer astronomer at an affordable price. All StarMax models feature correct-image finder, EQ mount, and soft-carrying cases for the optical tube.

StarMax 90 EQ
A compact, grab-it-and-go Maksutov-Cassegrain telescope that is a great value for beginners. The StarMax 90 provides a whole new level of versatility, visual clarity, portability and convenience.

A 90mm Mak-Cass design, 1250mm focal length (f/13.9), with 6x20 correct-image finder scope, 25mm Sirius Plössl eyepiece (1.25"), 90° mirror star diagonal, soft carrying case, and sturdy EQ-1 mount.

$279

StarMax 102 EQ
Set-up and break-down takes just minutes with this 4" Maksutov. Transportation is a breeze and its long focal length rewards the viewer with excellent planetary views, such as the Cassini divison of Saturn's ring or Jupiter's red spot. All of this at a very affordable price!

A 102mm Maksutov-Cassegrain design, 1300mm focal length (f/12.7), 6x26 correct-image finder scope, 25mm Sirius Plössl eyepiece (1.25"), 90° mirror star diagonal, soft carrying case, and EQ-2 mount.

$389

StarMax 127 EQ
For the serious amateur astronomer who values performance and quality optics, but also wants portability and easy set-up, the StarMax 127 EQ is just the ticket.

A 127mm Maksutov-Cassegrain design, 1540mm focal length (f/12.1), 6x26 correct-image finder scope, 25mm Sirius Plössl eyepiece (1.25"), 90° mirror star diagonal, soft carrying case, and a sturdy AstroView mount.

$569

MONEY-BACK
If you are not completely satisfied with your purchase from Orion Telescopes & Binoculars
100% Satisfaction
for any reason, just return it in new condition within 30 days after delivery for a prompt refund.
GUARANTEE

24 Hour Toll-Free Orders: (800) 447-1001
Information/Advice: (800) 676-1343
Information Line Hours: M–F 6am–8pm, Sat. 8am–6pm Pacific Time

Prices subject to change or correction without notice.

telescope.com

ACCESSORIES

Right Angle Correct-Image Finder Scopes

Our right-angle finder scopes let you view in contortion free comfort! What's more, they have built-in Amici prisms to provide a correctly-oriented, not upside down, view. Available in two sizes. Each comes with dovetail bracket.

6x30 Right Angle Correct-Image Finder Scope
$49.95

9x50 Right Angle Correct-Image Finder Scope
$76.95

EZ Finder™ II Reflex Sight

We've upgraded our EZ Finder with a new design and improved bracket—at a lower price. This aiming device superimposes a LED-powered red dot in a wide 10° field of view, showing exactly where the telescope is pointed. Now with a new bracket that fits the quick-release mounting base on many Orion telescopes.

$34.95

Orion Solar Filters

Catch this year's intense sunspot activity with a safe, full-aperture glass solar filter for your telescope. Sizes to fit many telescopes.
From **$54.95**

Padded Scope Cases

Protect your investment with a padded, polyester/nylon case. Strap handles for easy carrying. Many sizes.

From **$24.95**

SkyGlow™ Broadband LP Filters

Improves contrast of all objects in moderately light-polluted skies.

1.25" ~~$59.95~~
Sale $49.95
2" **$89.95**
SCT Rear Cell
$79.95

Planetary Filter Set

These vat-dyed glass color filters bring out fascinating surface details on the planets and Moon.

Set of 4 **$39.95**

Deluxe Aluminum Accessory Cases

Three different sized aluminum-clad accessory cases with pre-cut foam compartments, make it easy to organize and protect eyepieces, barlows, filters and other valuable accessories.

Sm **$22.95** Med **$32.95** Lg **$42.95**

Orion LaserMate™ Collimator

Align your Newtonian's optics to get the best possible images. This compact laser collimator removes the guesswork, making the procedure quick and extremely precise. Just 3-1/3" long!

DANGER
LASER RADIATION
CLASS IIIA LASER PRODUCT

Only **$69.95**

Atlas™ Heavy-Duty Equatorial Mount

New!

Our beefiest and most advanced mount offers amateur astronomers a rock-stable platform at a price unheard of before. Supports telescope tubes of up to 40 lbs. Atlas comes with dual internal DC stepper motor drives, 3" setting circles, polar alignment scope, 2" stainless-steel tube legs, and two 11 lbs. counterweights. Weight (without counterweights) 54 lbs.

$799

New!

SkyView Pro™ Equatorial Mount

Sets a new standard for stability, precision control, and affordability. Supports telescope tubes weighing up to 20 lbs. All-metal head features enclosed 360° worm gears plus large 86mm-diameter setting circles. Telescopes attach via a quick-release dovetail plate (included) that lock in place. Two counter weights (7.5 lbs. and 4 lbs.) included. Weighs 37 lbs.

$299

New!

RockStable™ Anti-Vibration Pads

Special visco-elastic material reduces vibrations from wind and other sources. Ideal for both visual astronomy and astrophotography. Sold in sets of three.

$48.95

EYEPIECES

Highlight™ Plössl Eyepieces

New!

Like the Sirius Plössl line, HighLight eyepieces offer a generous 50° field of view (43° for the 40mm) and crisp, sharp images. But the HighLight's 4-element optics are not just fully coated or multi-coated, but fully multi-coated. That means that every air-to-glass lens surface is multi-layer coated for the highest possible light transmission and better contrast. Rubber eyeguards.

FULLY MULTI-COATED!

6.3mm, 7.5mm, 10mm, 12.5mm, 17mm, 20mm, 26mm	$54.95
32mm, 40mm	$59.95

Expanse™ Wide-Field Eyepieces

New!

With their 66° apparent field of view, our Expanse wide-field eyepieces will definitely turn up the Wow! factor in your deep-sky observing experiences! Imagine taking in objects like the Andromeda Galaxy, the Double Cluster, or the star clouds in Sagittarius in one sweep! With an Expanse in your focuser, you can! Fully coated, rubber eyeguards.

6mm, 9mm, 15mm, 20mm **$49.95**

NEW LOW PRICE!

Sirius™ Plössl Eyepieces

You could pay twice the price for other brands of Plössl eyepieces, but why? Sirius Plössls are top-quality, 50° apparent-field (43° 40mm) eyepieces that yield extremely sharp images of impressively high contrast. Ideal for all types of telescopes. Fully-coated optics, rubber eyeguards.

1.25"

6.3mm, 7.5mm, 10mm, 12.5mm, 17mm, 20mm, 26mm	$39.95 each
32mm, 40mm	$44.95 each

Epic™ ED-2 Eyepieces

Our new ED-2 eyepieces are made of "Extra-low Dispersion" optical glass that boasts superior refractive properties. Epic 1.25" eyepieces feature a six-element lens design in which two of the elements are crafted from ED glass. Each provides luxurious 20mm eye relief, reduced chromatic aberration and a wide 55° apparent field.

NEW 18MM & 25MM

25mm, 22mm, 18mm, 14mm, 12.3mm, 9.5mm, 5.1mm, 3.7mm

$69 ea.

BINOCULARS

New!

Outsider™ WA 50mm

Super-wide angle field of view, long eye relief, BAK-4 prisms, and Fully coated optics.

10x50 WA **$59.95**

Mini Giant™ Binos

Now, two new high-magnification models—12x63 and 15x63

Compact astro binocs that show you the light! Fully multi-coated optics, BAK-4 prisms. Long eye relief (8x56: 18mm, 9x63: 26mm, 12x63: 17.5mm, 15x63: 19mm). Easily hand-holdable, but also tripod adaptable.

8x56	5.8° field	**$159**	**12x63**	4.7° field	**$199**
9x63	5.0° field	**$189**	**15x63**	3.7° field	**$199**

LONG EYE RELIEF!

UltraView™ 50mm

Extra-long 22mm eye relief makes these superb for eyeglass wearers! Fully multi-coated optics, BAK-4 prisms. New twist-lock eyecups. Tripod adaptable.

7x50	6.5° field	**$169**
10x50 WA	6.5° field	**$169**

MegaView™ 80mm Binoculars

Premium giant binoculars with high-power optics and cross-reinforced aluminum body and sliding tripod mounting post for optimum balance. Fully multi-coated 80mm lenses with BAK-4 prisms. Long eye relief.

15x80	3.5° field	**$479**
20x80 WA	3.5° field	**$489**
30x80 WA	2.3° field	**$499**

EXTENDABLE DEW/GLARE SHIELDS!

ORION
TELESCOPES & BINOCULARS
P.O. BOX 1815-S, SANTA CRUZ, CA 95061

telescope.com

ORION
Deep Space in Your Face

FREE Full Color Catalog
Call (800) 447-1001

MasterCard DISCOVER NOVUS VISA AMERICAN EXPRESS

When ordering, mention key code VMA

ASTEROID FOR

NASA computer simulations have predicted that asteroid 1950 DA may strike Earth in the year 2880 (the approach depicted here by a composite image of Eros and Earth). NASA/GSFC

THE MILLENNIUM

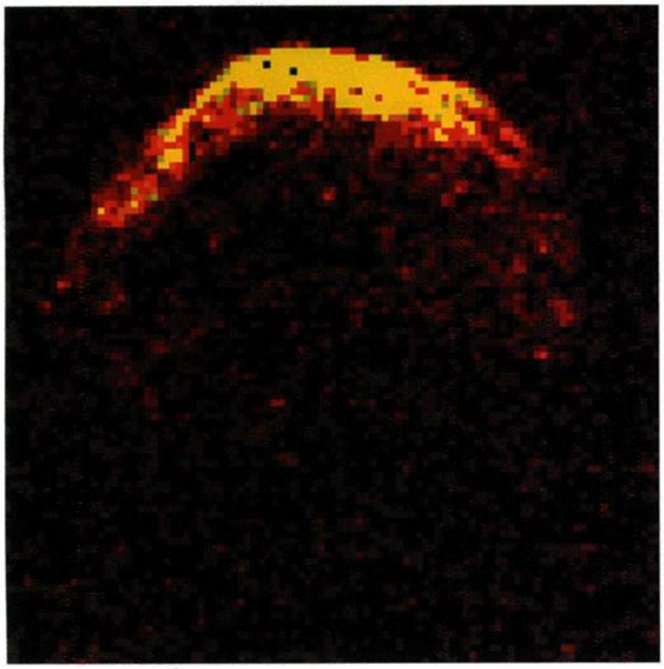
Asteroid 1950 DA might collide with Earth 900 years from now.
But already this object's peculiar orbit is giving planetary scientists a new way
to study and possibly deflect such troublesome space rocks.

by David L. Chandler

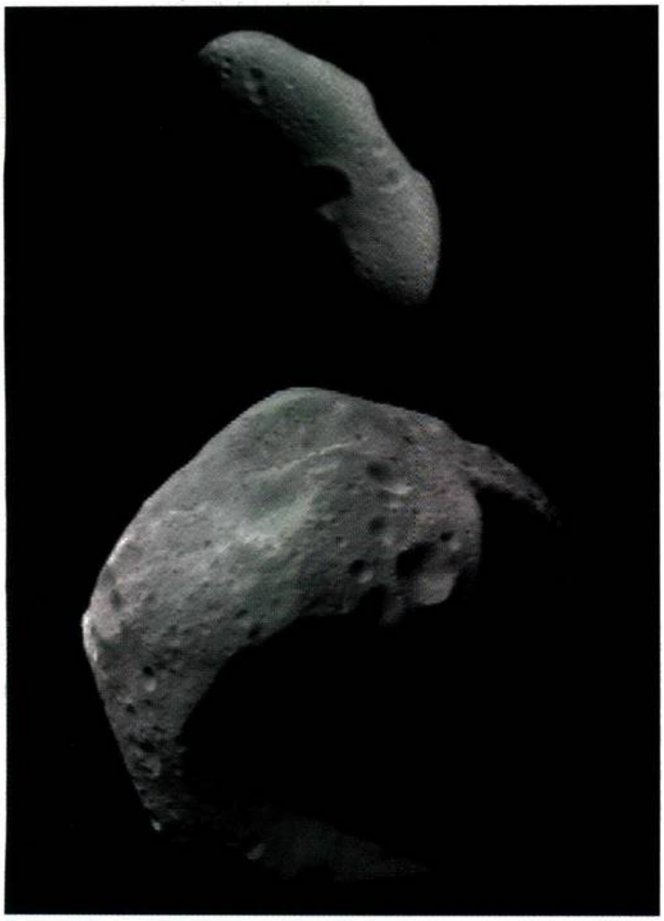
It was March 4, 2001. Jon Giorgini didn’t really expect anything special from that day’s observations. Asteroid 1950 DA was not even the main objective. It was a last-minute target of opportunity, added when the observers realized it would come within reach of radar from the Goldstone and Arecibo radio telescopes. So when Giorgini, a radar astronomer at NASA’s Jet Propulsion Laboratory, sat down at his computer to examine the new data, he had no idea what lay ahead. ☾ Detailed radar observations of potential Earth-threatening asteroids are crucial for calculating their orbital trajectories. Fortunately, this radio data usually makes any whiff of risk — and the impending media frenzy about a Doomsday Rock — go away. Unfortunately, some near-Earth asteroids pass where planetary radar can lock onto them. ☾ In the case of 1950 DA, however, calculations had already ruled out the possibility of an impact anytime in the next century. Still, planetary scientists don’t like to pass up radar observations of near-Earth asteroids because such opportunities are relatively rare. Also, radar is the only way short of a big-budget spacecraft mission to detail an asteroid’s size and shape. So as soon as the first data came in, Giorgini immediately went to work.

A ROCKY FUTURE

Radar data quickly gave a precise position and motion for 1950 DA, within an accuracy of better than 0.6 miles (1 km) in location and 1.5 inches (3.5 cm) per second in speed. Giorgini then used an orbit-prediction computer program to see how far into the future such forecasts could go before degenerating into chaos. He knew from experience that no predictions work for more than about a century ahead. ☾ But as the figures began to pop out on the computer screen, what he saw astonished him. The table of possible encounters marched forward century after century. Way out in



Asteroid 1950 DA imaged using radar with the Arecibo telescope in Puerto Rico on March 3-7, 2001. At the time, the asteroid was 13 million miles from Earth. Steven Ostro (JPL)



In this montage, asteroids Eros (top) and Mathilde (bottom) are shown at the same scale as imaged by the NEAR Shoemaker spacecraft. Mathilde's brightness is exaggerated for viewing purposes — it's actually six times darker than Eros with about the same reflectivity as soot. NASA

2641, the uncertainty was still only a couple of Earth-diameters wide — an absurdly small figure for such a long timespan. And then, barely hours after the first radar echoes bounced back into the Goldstone dish, came the clincher: March 16, 2880, a date during which 1950 DA could slam into Earth. The probability was 1 in 300 — far higher than any impact prediction ever made. How quickly Giorgini learned not to forget this space rock.

Previous radar readings had always eliminated the possibility of 1950 DA impacting Earth. This time, however, a collision was more likely. Worse, if it did happen, the asteroid would surely cause widespread devastation. At roughly three quarters of a mile (1.1 km) across, 1950 DA is big enough to cause immense damage. Such an impact would directly destroy an area the size of Wisconsin, spread wildfires across an entire continent, and cause dramatic shifts in climate worldwide.

If it weren't nearly nine centuries away, the prospect would be downright terrifying.

OUT OF THE NIGHT

Asteroid 1950 DA was discovered on February 23, 1950, and it was then observed and photographed for 17 days before being lost. It stayed lost for a full half-century before helping to ring in the New Year on December 31, 2000, when it showed up in an asteroid discovery program at Lowell Observatory. The space rock was designated 2000 YK66.

1950 DA's return was unexpected since the original observations were inadequate for prediction. On the discovery night, Conrad Bardwell was manning the Minor Planet Center at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts. An astronomer emeritus, Bardwell was around for the asteroid's initial discovery, and he has remained interested in it ever since. He saw the coordinates for 2000 YK66 and within just two hours had figured out this new object was actually the long-lost 1950 DA.

The 50-year baseline of observations provides a rare amount of precision in determining 1950 DA's orbital path. Only a handful of other near-Earth asteroids have been observed as long. But neither the long timeline nor the radar's precision measurements can explain why 1950 DA's orbit is predictable so far into the future.

The unique predictability of 1950 DA hinges on something completely unexpected — a new discovery, which Giorgini and 14 collaborators reported in the journal *Science* for April 5, 2002. The secret of 1950 DA's predictability lies in what scientists call a resonant orbit.

GETTING IN THE SWING

It turns out that 1950 DA has an 11-to-5 orbital resonance with Earth. Translated into everyday language, that means every time 1950 DA makes five complete circuits around the Sun, the Earth makes exactly 11 orbits. Thus Earth and the asteroid return to virtually the same relative positions every 11 years. Such resonances are well known among the solar system's moons, but nobody had anticipated the effect of such a synchronized minuet on the long-term evolution of an asteroid's orbit.

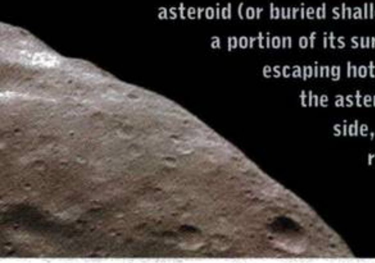
The effect is rather dramatic and had never been predicted by theorists. Partnership in a resonant orbit greatly reduces uncertainty of an asteroid's future orbit, even as encounters with planets and other asteroids push and pull it every which way. If it gets pulled a little forward in its orbit, resonance acts to draw it back. Every time perturbations start to drag it backward,

HOW TO MOVE A WORLD

One day scientists will observe an asteroid with Earth's name on it — what then? Several solutions lie at hand, at least in theory:

- Nuke it. A nuclear explosion next to the asteroid (or buried shallowly) vaporizes a portion of its surface. The escaping hot gases nudge the asteroid to one side, or hasten (or retard) its orbital velocity. (A big-enough nuke could also fragment the body completely, but that might mean Earth just gets hit by cosmic buckshot instead of one big slug — not a pleasant alternative.)
- Smack it. A direct impact on the asteroid from a fast-moving, massive, inert object deflects its course.
- Warm it/Cool it. Coat one side of the asteroid with light (or dark) material. As sunlight heats the surface, the Yarkovsky effect generates thrust and alters the asteroid's orbit.
- Cook it. A giant Mylar mirror focuses sunlight on part of the asteroid. The jetting vapor from the surface changes the object's orbit.

Clearly, smaller rocks are easier to deflect than larger ones, but the key ingredient in every scheme is time. The longer we have to work before the collision, the easier it is to avert the disaster. — *Robert Burnham*



Earth's attraction pulls it forward. Thus 1950 DA can never stray far from its mean orbital solution.

Giorgini and his colleagues used a standard computer simulation for 1950 DA's orbital evolution, tracking instead 10,000 virtual asteroids. After a few decades of computer-modeling time, such simulations usually show a chaotic spread in possible orbits, rendering them worthless for predictions. However, in this case, every time the "envelope" of orbit solutions started to grow uncertain, it pinched back down again. After 600 years, the region of uncertainty in the asteroid's position was still only 12,500 miles (20,000 km) long — less than twice Earth's diameter.

Then in 2641, "that resonance is disrupted, if not broken," says Giorgini. A close encounter with Earth, although it will not produce a collision, does alter the resonant relationship forever. "The uncertainty is confined for 600 years, and then it very quickly spreads out to a region of several million miles," he says.

Much of the asteroid's positional uncertainty comes at the end of the calculation period. By then it has built up to an 18 million-mile swath, following further close brushes with Earth in 2809 and 2860. The latter date is just 20 years before the potential Earth impact.

PLUS OR MINUS

The preliminary calculations revealed both an incredibly long period of stability and high odds of a collision. So Giorgini and his JPL team, including orbital-determination experts Don Yeomans and Paul Chodas, along with asteroid radar pioneer Steve Ostro, decided to use 1950 DA as a test case. They would examine every kind of force, effect, and phenomenon that could conceivably change the terrifying outcome.

For 1950 DA, virtually all uncertainty lies along its orbital path. This means that the asteroid's orbit almost certainly will intersect Earth's orbit on March 16, 2880. But the vitally important question is, will the asteroid and Earth arrive at the same point at the same time?

There is a 20-minute window in 1950 DA's "nominal" orbital track that could lead to an impact. A wide variety of effects could nudge the asteroid's position backward or forward between now and then. These effects include the gravitational pull of asteroids and galactic tides, the push of solar wind and radiation pressure, the oblateness of the Sun's shape, uncertainties in the masses of the planets, and effects from the re-radiation of solar energy. How much could these alter the likelihood of an asteroid-induced Doomsday for Earth?

Giorgini's team first considered the possible gravitational perturbations not only by all the planets, but also from a mind-boggling 7,196 asteroids — actually, every asteroid known to be larger than 6.2 miles (10 km) in diameter. Of these, 2,051 were found to produce a total of 28,199 approaches to 1950 DA over the next 880 years. The cumulative effect of all these was a net change of just over a day in the orbital position in 2880 — they retard its arrival by 1.2 days.

Then the team looked at variations in the Sun's shape from the idealized sphere used in basic orbit computations. A slightly out-of-plane orbit like 1950 DA's — inclined 12° from Earth's — makes a subtle difference and can actually have a noticeable effect. It could add an uncertainty of about 70 minutes to its orbital position.

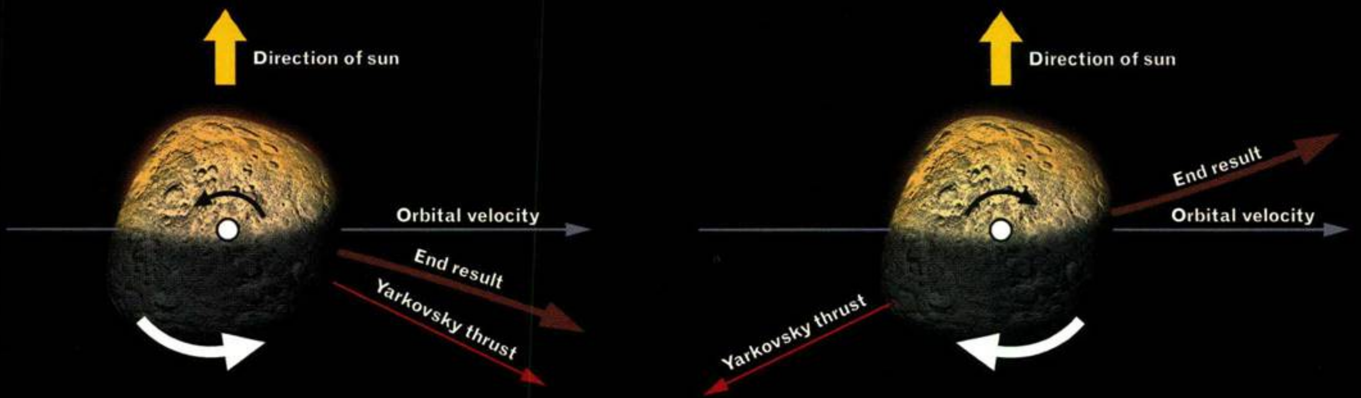
The effects of the solar wind and radiation pressure on the orbit were much bigger — a total retardation of arrival time by 9.1 days. The uncertainties in the mass determinations of the planets add a possible uncertainty of 2.4 days (1.1 to –1.3 days in arrival time). Other effects such as galactic tides, mathematical errors because of rounding in the computers, and the loss of mass by the Sun, produced a tiny cumulative net effect of –6 minutes.

THE WHAT EFFECT?

But the biggest effect, the one whose uncertainties make it impossible to refine the impact odds for the foreseeable future, is one that most people had never even heard of until 1950 DA came along — the Yarkovsky effect (well-known among spacecraft engineers, however.) Named for an obscure Russian civil engineer who discovered it around 1900, the Yarkovsky effect ordinarily concerns only small, easily deflected bodies like spacecraft. In the last few years, however, planetary scientists have begun to consider that this odd, tiny effect could also make a difference to relatively massive bodies like asteroids.

What is the Yarkovsky effect? It's a minuscule impulse provided by the re-radiation of absorbed solar heat by a spinning body. The magnitude of the impulse depends on the asteroid's spin rate and orientation, its surface composition and shape, and even its color and reflectivity — none of which are known very precisely in the case of 1950 DA. Re-radiated heat acts like a tiny rocket thruster, but whether the force pushes or pulls the asteroid depends on the orientation of its axis relative to its orbit. The Yarkovsky effect is certainly subtle. But over the course of centuries, it may make a big difference in what happens on that fateful day just before spring arrives in

THE YARKOVSKY EFFECT



Visit the *Astronomy* magazine page at *Astronomy.com* to view an animation showing the Yarkovsky effect in action.

Astronomy: Elisabeth Rowan

Mere sunlight can change the orbit of an asteroid. Here's how: Sunlight falling on a spinning object in space heats its surface. But the heating is asymmetrical. Just as afternoons on sunny days are hotter than mornings, the afternoon side of an asteroid has a warmer surface than the morning side because sunlight has been falling on it longer.

Since hot surfaces radiate more than cool ones, the warm afternoon side radiates more than the cool morning side. This imbalance acts like a very weak rocket engine.

The effect of this tiny thrust on the object's orbit depends on how it spins. If the spin goes one way, Yarkovsky thrust adds to the orbital speed and the asteroid moves outward, away from the Sun. If the asteroid rotates the other way, Yarkovsky thrust slows the asteroid's orbital velocity, and it draws closer to the Sun.

Real asteroids can have spin axes oriented in any direction relative to their orbits, so the Yarkovsky effect in each case depends on the actual circumstances. — *R. B.*

2880. This one effect alone could change the arrival time by almost 10 days forward or nearly two months (57.7 days) backward. In all, it accounts for about 68 days of additional uncertainty.

HEADS OR TAILS

The key factor determining how the Yarkovsky effect will alter 1950 DA's future (and ours) depends on the asteroid's rotation. Literally, it's a coin-toss. Radar observations yield two sets of possible solutions for the asteroid's spin axis. If it spins one way, we're stuck with those 1-in-300 odds. If the spin axis goes the other way, the odds of impact instantly drop to zero. With close to 50–50 odds of the axis being one way or the other, a flip of the coin may determine the threat.

Just how is 1950 DA oriented in space? Absent an expensive spacecraft mission or some clever new ground-based technique, the next opportunities to learn more about the asteroid's spin lie a long way off. Radar observations could nail down the spin axis, but the next opportunity doesn't come until 2032 — and that approach is actually more distant than the one in 2001. Another, still more distant, chance comes in 2074. Not until 2105 will 1950 DA approach closer than in 2001.

But if the Yarkovsky effect befuddles our current attempts at prediction, it could also end up being our savior in the event that this asteroid really does have a date with the Earth in 2880. What re-radiation can cause, it can also undo. If it turns out that we're on a collision course, all we need to do is alter one or more of the physical parameters controlling 1950 DA's Yarkovsky effect — very, very carefully, and of course after a lot of checking and double checking.

Among the factors that control the Yarkovsky effect, changing the spin of a kilometer-wide asteroid is not practical, and changing its composition is out of the question entirely. But reflectivity has a significant effect, and might be relatively easy to alter. A dark surface might be brightened by dumping loads of chalk or ice crystals on it, or covering the asteroid in a huge, reflective Mylar sheet — just like a baked potato wrapped in tinfoil. If 1950 DA has a bright surface (perhaps from a layer of ice) then we could darken it with loads of charcoal dust or soot. Or we might selectively darken some parts and lighten others. These techniques won't go wasted. Even if 1950 DA turns out to be benign after all, harnessing the Yarkovsky effect may some day help steer other errant asteroids out of our way.

THINKING LONG TERM

1950 DA has taught planetary scientists enough to give this orbiting mountain a unique place in the annals of space science. It's a concrete symbol of the hazards we face as residents of a solar system that's still evolving. Like the proverbial sword of Damocles, 1950 DA will probably loom over humanity for decades, a constant threat to our civilization. Its threat, in fact, could remain unresolved even for centuries.

"This one isn't going to go away," says Brian Marsden, director of the Minor Planet Center.

This extraordinary object, the likeliest impactor and the most predictable asteroid yet discovered, will remain a major focus of small-body research for a long time. If an imminent collision course is real, we'll have our work cut out for us. The process of devising a plan, and carrying out the first rescue of our world from a devastating blow from above, could be a project that prods human consciousness for much of the millennium to come.

It's no wonder then that Giorgini calls 1950 DA "an asteroid for the millennium."

David L. Chandler is a freelance science writer. He formerly covered science for the Boston Globe.

Get a whole **new** look!

Nikon binoculars.
Let the adventure begin!

Astroluxe XL
- All metal construction for durability
- Nikon's superior technology
- BaK4 high index prisms
- 100% Waterproof/Fogproof model available 18x70

camcor.com
800-868-2462
www.camcor.com e-mail:sky@camcor.com
2273 South Church St. • Burlington, NC 27215 • Fax # 336-222-8011 • 336-228-0251

Nikon
A better look at your world

25-year limited warranty included on all Nikon binoculars. ©2002 Nikon Inc.

www.nikonusa.com

Rivers CAMERA SHOP

AUTHORIZED MEADE® APD MAIL-ORDER DEALER

Huge Selection of Meade Eyepieces & Accessories in Stock & Ready for Immediate Shipment!

- LX-200 GPS
- ETX 125, 105, 90, 70
- LX 55 Series 10"- 6"

Meade LX90 on display

LX90 $1,695 +95 P&S

Why Buy From Us?

NE's Largest Telescope Display

Mail-Order or In-Store.

Used Scopes — Buy, Sell or Trade-In

Knowledgeable, Helpful, Friendly Staff

TeleVue®

AUTHORIZED CELESTRON® DEALER

Nexstar Telescopes in stock

Rivers CAMERA SHOP
454 Central Ave., Dover, NH 03820
Orders: (800) 245-7963
Info: (603) 742-4888
Fax: (603) 742-5456
Hours: M-TH 8:30-6:00, Fri. 8:30-8:00, Sat. 9:30-5:00

www.riverscamera.com

Call us for a quote on your Telescope purchase!

Over 2500 products in-stock and ready-to-ship!

New ETX-90RA's from $199

ETX-70/AT **now $250**
with Autostar controller!

ETX-105/EC
90/EC • 125/EC
Call Toll-Free for pricing

Meade LXD-55's

Achromatic Refractors:
5" & 6" w/Autostar

Schmidt-Newtonians:
6", 8", and 10" w/Autostar

20% Brighter!

LX200 "GPS" New! See our website for complete specs!

Meade LX90 & LX200

Celestron NexStar Family!

8" & 11" **GPS**

5" & 8" **GPS**

80mm Refractor
4.5" Newtonian

4" Maksutov

Meade Eyepieces:	
Zoom 8-24mm	$220
Super Plossl 6.4, 9.7, 12.4, 15, 20, or 26	80
SP32 or 40mm	100
SP56mm	200
Super Wide 13.8	140
Super Wide 18	150
Super Wide 24.5	180
Super Wide 32	240
Super Wide 40	300
Barlow 2x #140	80

Meade Eyepieces:	
Ultra Wide 4.7	$170
Ultra Wide 6.7	200
Ultra Wide 8.8	240
Ultra Wide 14	300
Illum 12mm Astro	120
Illum 25mm-CCD	130
Illum 12mm w/cord	80
Illum 12mm-w/batt	100
Illum 9mm w/cord	130
Illum 9mm-w/batt	150
Meade Accy's:	
505 Software set	55
506 Software set	50
Autostar #497	149
AC adapter #541	50
AC adapter #546	22
AC #547 (GPS)	70
Car cord #607	30

Meade Accy's:	
Cable #505	$30
Case #773 (60/70)	64
Case #774 (90)	100
Case #775 (125)	150
Case #776 (105)	100
Case 7/8/10/12"	call
Dew shield 670	20
Dew shield 673	25
Dew shield 675	28
Dew shield 678	30
Epoch 2000 CD	100
Filter set #3200	40
Filter set-1, 2, or 3	50
Finder #825	52
Finder #827	52
Focuser #1244	124
Focuser #1247	124
Flip-mirror #644	150
Flip-mirror #647	250

Meade Accy's:	
Focal reducer f:6.3	$130
Focal reducer f:3.3	150
Lenshood 7-12"	call
Nebula 908 B	80
Nebula 908 N	90
Nebula 908 O-III	100
Nebula 911 B	100
Nebula 911 N	120
Nebula 911 O-III	150
Off-axis guider	87
Prism 45° #932	50
Prism 45° #933	50
Pictor 416XTE	1999
Piggy brkt 7-12"	call
Prism 2" 90° UHTC	105
Skylight/seal	50
Tripod #880	32
Tripod #881	62
Tripod #882	100

Meade Accy's:	
Tripod #884 w/cs	$200
T-adapter #64	37
T-adapter #64ST	20
Tele ext-variable	40
T-adapt: SCT	30
T-adapt: vari-proj	40
T-adapt: 1.25"	30
Vibration pads	50
Vari pol 905	50
Weight sets	call
Wedge LX90	162
Wedge 8" LX200	148
Superwedge	399

Promaster 35mm AstroCam $220
Full manual!

Glass Solar Filters:
Yellow-orange image, Lifetime warranty!

ETX60/70	$70
ETX90/105	80
ETX125/Next-5	102
8" full aperture	139
10" full aperture	159
11" full aperture	179
12" full aperture	189

ProStar Lenshoods:	
ETX flexible	call
8" flexible	49
8" **metal**	129
10" flexible	59
10" **metal**	139
11" **metal**	169
12" flexible	74
12" **metal**	189

TeleVue Eyepieces, Barlows, and Diagonals

Plossl-50°	
8, 11, or 15	$83
20 or 25mm	95
32 or 40mm	112
55mm	228
Panoptic-68°	
15mm	$210
19mm	240
22mm	280
27mm	330
35mm	365
Radian-60°	
3, 4, 5, 6, 8, 10, 12, 14, or 18 ea.	240
Diagonals:	
2" Everbrite	275
1.25 Everbrite	190

Nagler-82°	
5mm Type6	$280
7mm	190
7mm Type6	280
9mm Type6	280
12mm Type4	355
13mm Type6	280
16mm Type5	320
17mm Type4	385
22mm Type4	460
26mm Type5	580
31mm Type5	620
Barlows:	
1.25" 2x or 3x	107
1.25" 2.5x or 5x	170
2-inch 2x	198
2-inch P-Mate	280
2-inch 4x	295

2002 SHUTAN camera video

<<FREE CATALOG<< **We also carry JMI, Lumicon, JMB, Scopetronix, 1000 Oaks, Starry Night, Software Bisque, Starbound, Cambridge Press, Kendrick, Rigel, Schmidling, Telrad, Losmandy, Firefly Press, Ken Press, and others!**

Order our 84-Page catalog toll-free or online! Most merchandise orders ship same day. Shutan is family owned and operated since 1918! All prices subject to change and do not include S/H. Mail-order prices shown. ©9/02 SCV **>>Sign-up for EXCLUSIVE E-Mail Specials at www.Shutan.com<<**

SHUTAN *camera & video*

We welcome bids & PO's from Schools!

Toll-Free 800-621-2248
Illinois 847-367-4600 • www.shutan.com
100 Fairway Dr. • Vernon Hills IL • 60061

Here's An Eye-Opening Offer!

Purchase **any** Celestron telescope and buy this exclusive Accessory Kit for ONLY $99!*

ACCESSORY KIT

Seeing is believing!

Purchase **any** Celestron telescope **by December 31, 2002**, and you can take home this complete accessory kit **immediately** for **ONLY $99**. Best of all, Celestron is taking all of the hassle out of purchasing this set because you won't need to mail us any paperwork or check. You deal directly with your dealer at the time of purchase. This special offer is a way of showing our appreciation to our many past, present, and future customers for their support of Celestron and its products for over 40 years, and to celebrate the era of the "new" Celestron.

The accessory kit contains:

- **Five Superior Grade Plössl Eyepieces** - 1.25" — 4-element design with a 52° AFOV (32mm has 44°) — Superb color, resolution, edge sharpness and clarity. All eyepieces are fully multi-coated for maximum contrast and resolution. Supplied are a 4mm,6mm, 9mm, 15mm, and 32mm.
- **Barlow Lens** - 2x 1.25" — Compliments the Plössl eyepieces in this kit and gives you a total of ten power combinations. The highest grade glass optics with fully multi-coated lenses are used so there is no degradation of image.
- **Six Colored Eyepiece (Planetary) Filters** - 1.25" — Included are Kodak Wratten #12, #21, #25, #56, #58A, and #80A. Since you have all the eyepieces necessary to study the planets and moon in detail, these filters will greatly enhance your enjoyment of our solar system.
- **Moon Filter** - 1.25" — A neutral density filter which allows you maximum enjoyment of the moon especially during the brighter phases.
- **Aluminum Carrying Case** — This sturdy and well-built case fits all of the above items in the die-cut foam interior and has room for additional accessories.

Rugged carrying case is included!

***This special $99.00 offer ends December 31, 2002.**

The items in this kit are valued at over $700.00 if purchased separately!

Regular retail price of this kit is $399.00

CELESTRON

Celestron
2835 Columbia Street • Torrance, CA 90503 • 310.328.9560
www.celestron.com

© 2002 Celestron

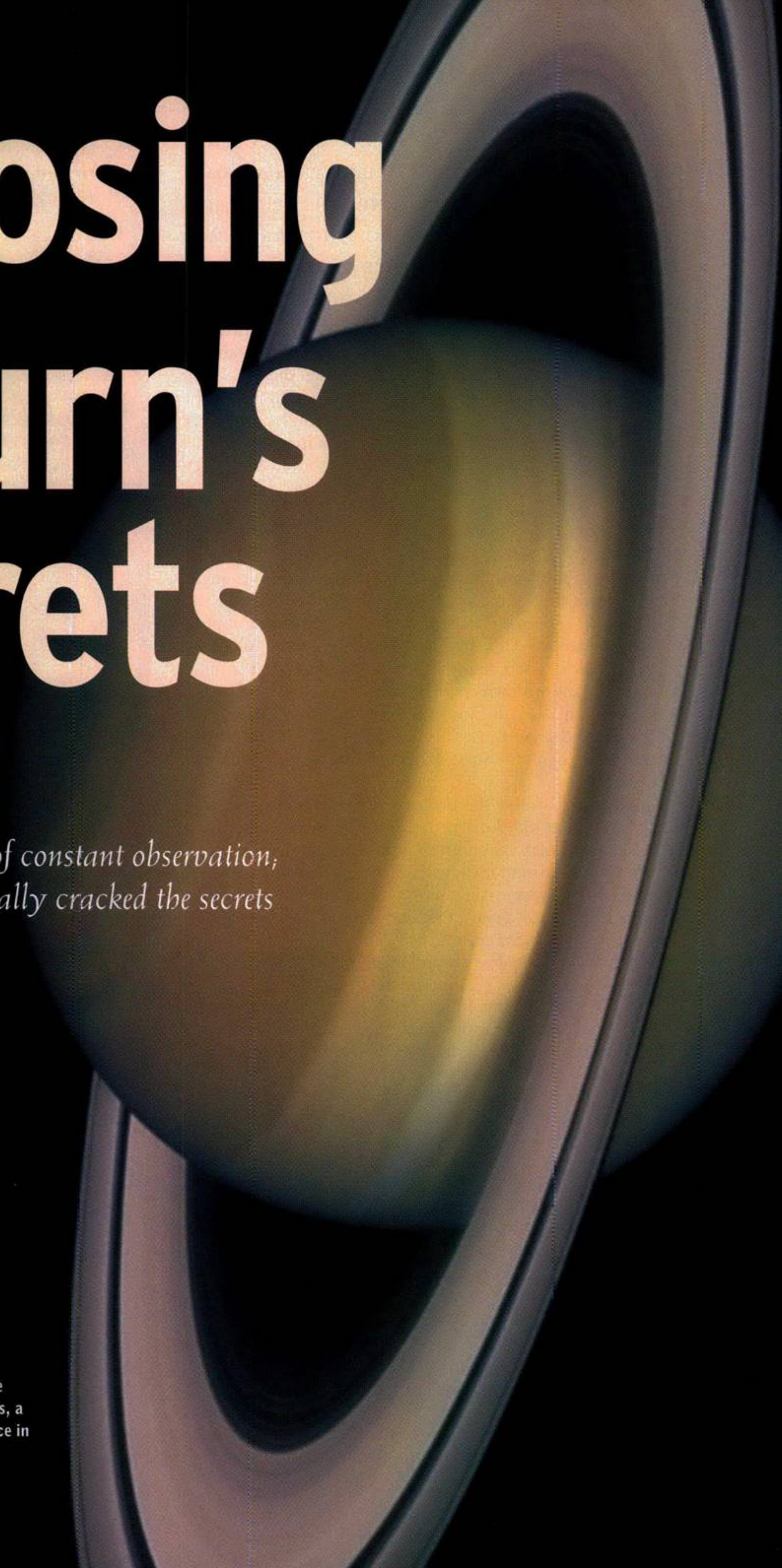
Exposing Saturn's secrets

It took nearly 400 years of constant observation; here's how astronomers finally cracked the secrets of Saturn's rings.

by Alan Rubin

Copyright © 2002 by Princeton University Press.

From the book entitled *Disturbing the Solar System*
by Alan Rubin, published by Princeton University Press.
Printed by permission.



The Ringed Planet poses for the Hubble Space Telescope in October 1998. Saturn's thin rings, a mere 30 feet thick, are made of dusty water ice in boulder-sized and smaller chunks.

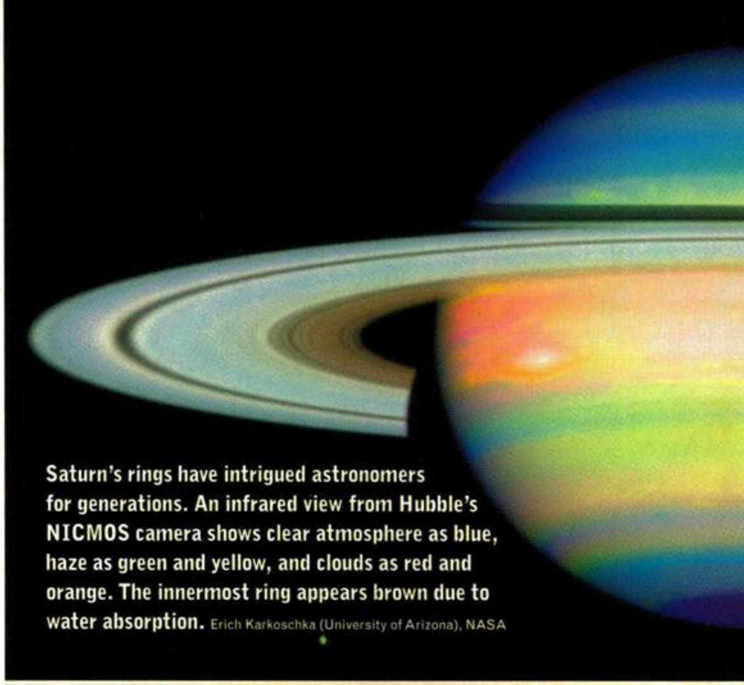
NASA and the Hubble Heritage Team (STScI/AURA)

Three hundred-eighteen years before Walt Disney produced *Steamboat Willie*, Galileo peered into the heavens and saw "Mickey Mouse." What startled Galileo that summer night in 1610 when he trained his crude spyglass on Saturn was a glowing planetary globe with "ears." He wrote that, "Saturn is not a single star, but three together, which touch each other. With a telescope which magnifies 1,000 times, the three globes can be seen very distinctly, almost touching, with only a small dark space between them." Galileo observed that Saturn's appearance did not change over the course of more than a year. If the "ears" or "handles" had been moons revolving around Saturn as Jupiter's moons revolved around Jupiter, changes in their positions should have been noticeable every few days. Perplexed at Saturn's peculiar appearance and anxious to work on other projects, Galileo stopped observing Saturn for over a year. When he returned to it in late November 1612, he was astonished to find that the triple star had vanished; only a solitary globe remained. "Now what can be said of this strange metamorphosis?" he wrote. "That the two lesser stars have been consumed, in the manner of the sunspots? Has Saturn devoured his children?" Betraying a rare loss of confidence, Galileo wondered whether the ears had been "an illusion and a fraud with which the lenses of my telescope deceived me for so long — and not only me, but many others who have observed it with me?" Nevertheless, Galileo predicted that Saturn's companion stars would return in due course. They did.

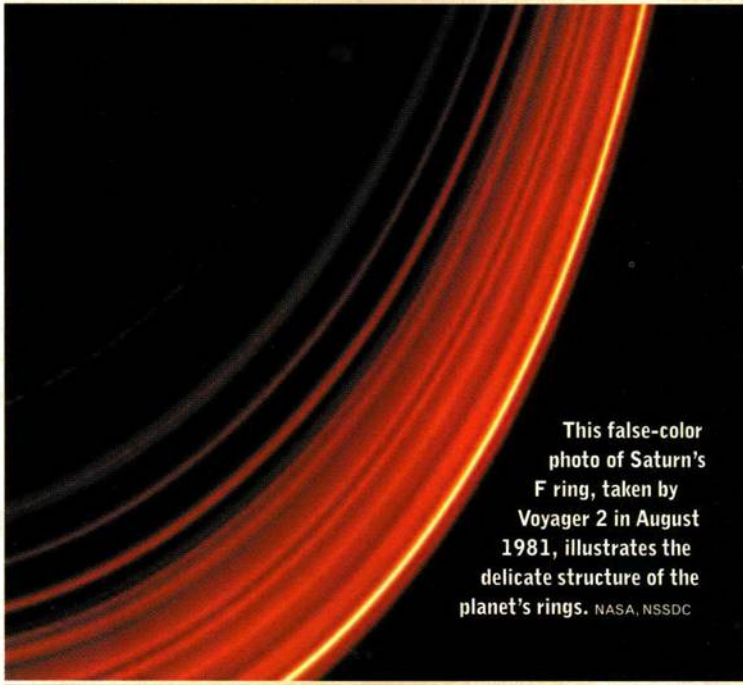
Galileo never solved the mystery of Saturn's disappearing-reappearing ears, but the first step toward a solution was made in 1655 when Dutch astronomer Christiaan Huygens discovered Saturn's sole large moon, Titan. Huygens saw that Titan revolved around Saturn every 16 days. From Titan's orbital movements and Saturn's motion against the fixed stars, Huygens concluded that Saturn was tilted more than 20° relative to the ecliptic (the plane of Earth's orbit around the Sun and nearly the same plane as Saturn's orbit). The modern value of Saturn's tilt is 26.73°, not too different from Earth's tilt of 23.45°. Huygens assumed that Saturn's handles were probably in the same plane as Titan's orbit. Because the handles were closer to Saturn than Titan was, they should revolve around the planet in less than 16 days. Huygens reasoned that a broad, flat, homogeneous ring would not change its appearance as it revolved around Saturn. In addition, if the ring were very thin, it would seem to disappear when viewed edge-on from Earth.

Huygens published a pamphlet in 1656 disclosing his discovery of Titan and including an anagram of his interpretation of Saturn's ring. Three years later he published *Systema Saturnium* and included the solution of the anagram: Saturn had a "thin flat ring, nowhere touching [the planet] and inclined to the ecliptic."

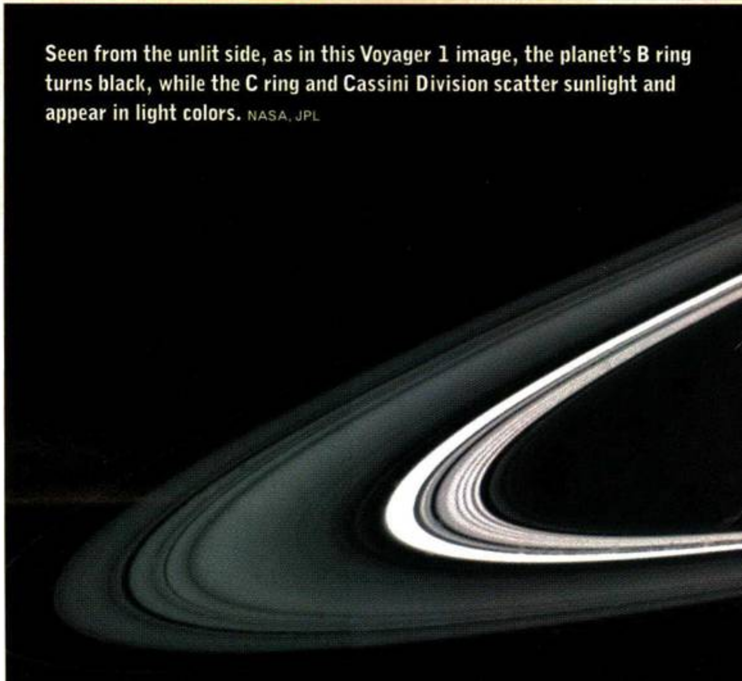
In later years, Huygens used the ring hypothesis to predict Saturn's telescopic appearance. As his predictions were verified, astronomers came to accept the idea of Saturn as a ringed planet. Their drawings showed a broad flat ring, just as Huygens had observed. This consensus lasted until 1675, when astronomer Jean Dominique Cassini reported a dark line (now known as the Cassini Division) within the rings, dividing them into two segments — an inner ring and an outer ring.



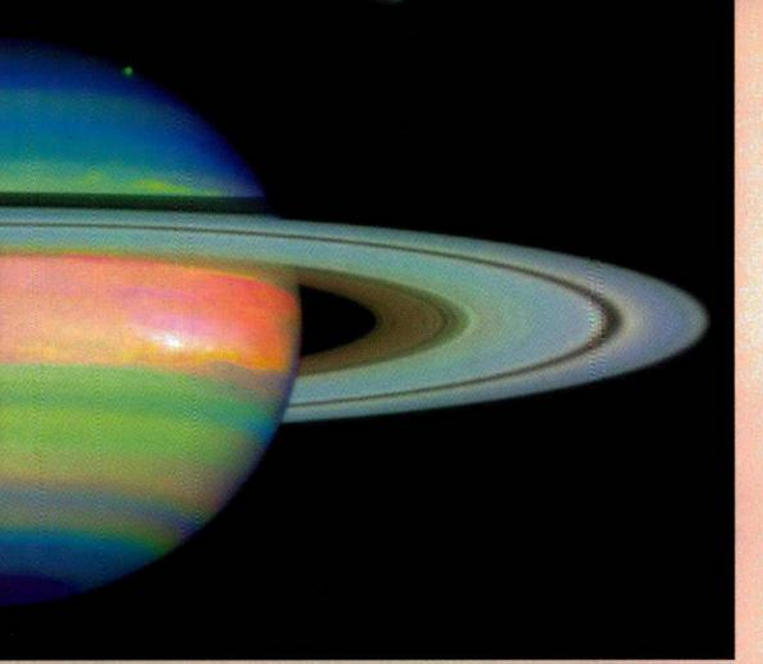
Saturn's rings have intrigued astronomers for generations. An infrared view from Hubble's NICMOS camera shows clear atmosphere as blue, haze as green and yellow, and clouds as red and orange. The innermost ring appears brown due to water absorption. Erich Karkoschka (University of Arizona), NASA



This false-color photo of Saturn's F ring, taken by Voyager 2 in August 1981, illustrates the delicate structure of the planet's rings. NASA, NSSDC



Seen from the unlit side, as in this Voyager 1 image, the planet's B ring turns black, while the C ring and Cassini Division scatter sunlight and appear in light colors. NASA, JPL



Encke's division runs prominently through Saturn's A ring in this Voyager 2 image, taken in August 1981 at a distance of 1.7 million miles (2.8 million kilometers). NASA, JPL

Rings, Ringlets, and Resonances

Most observers agreed that the double rings were probably very thin; otherwise, they would still be visible when viewed edge-on. But the question soon arose of how thin, solid rings could withstand the strain of being so near to Saturn. The dilemma was addressed by Cassini and others, who suggested that the rings were not solid disks but rather consisted of a swarm of small moons or particles, each orbiting independently. Contrary to Cassini's interpretation, the eminent German-English astronomer William Herschel declared the rings to be solid. Pierre-Simon de Laplace modified this suggestion and modeled the rings as a multitude of solid narrow ringlets, one inside the other, each orbiting Saturn at its own rate.

Over the following decades, observers reported myriad contradictory observations. Some saw only the Cassini Division; some saw two dark lines separating the rings, some three dark lines, others six. One team reported a "great number of narrow rings . . . not unlike a series of waves." The only new feature most observers recognized was a gap near the center of the outer ring discovered by Johann Encke (and now known as the Encke Division).

In 1850 astronomer William Dawes and the father-and-son team of William and George Bond discovered a faint third ring inside the other two. The new ring was called ring C, the middle ring (the one planetward of the Cassini Division) was called ring B, and the outer ring was called ring A. In 1852 a few astronomers reported they could see Saturn shining through the C ring, thereby providing strong evidence against Herschel's idea of solid rings. Scottish physicist James Clerk Maxwell laid the idea of solid rings to rest in 1857 by demonstrating that any slight perturbation (for example, by the gravitational pull of a small moon) in the orbit of a solid ring would cause one side of it to drift closer to the planet. This side would then be tugged on by Saturn to a greater extent than the opposite side of the ring and would drift even closer. Saturn's gravity would accelerate the drift, and the closer part of the ring would crash into the planet. Maxwell concluded, "The only system of rings which can exist is one composed of an indefinite number of unconnected particles revolving around the planet with different velocities according to their respective distances."

But what causes the gaps in the rings? In 1866 American astronomer Daniel Kirkwood had proposed that gaps in the orbital periods of asteroids were due to resonances with Jupiter. For example, asteroids that orbited the Sun twice for every single time that Jupiter orbited the Sun were in Jupiter's proximity every second orbit. Gravitational tugs by Jupiter modified the orbits of these asteroids into ones of higher eccentricity. This resulted in a paucity of asteroids with these orbital periods. In 1867 Kirkwood proposed that the gaps in Saturn's rings were caused by the same basic mechanism, this time by resonances with Saturn's moons. For example, any particles that drifted into the Cassini Division would orbit the planet with a period one-half that of Saturn's moon Mimas. The repeated gravitational tugs by Mimas would nudge the particles out of the division.

During the following decades, observers made numerous contradictory reports of gaps in Saturn's rings, many corresponding to resonances with Mimas. Kirkwood had predicted where the gaps should be, and observers, pushing the resolution limits of their telescopes, provided them in great numbers.

Vanishingly Thin

Theoreticians turned their attention to why Saturn's rings were so thin. In 1920 British astronomer Sir Harold Jeffreys reasoned that the rings must be vanishingly thin. If Saturn had started out with a spherical swarm of particles orbiting the planet in every direction, mutual collisions would have caused the particles to lose energy. Each particle would tend to reach the average velocity of all the particles. Furthermore, a rapidly rotating gas giant like Saturn has a substantial equatorial bulge that distorts the gravity field and causes the plane of each of the particles to wobble. Particles in inclined or eccentric orbits would tend to collide with other particles; the result would be for the particles to achieve a circular orbit in the planet's equatorial plane. In the absence of other forces, the ring would be one particle thick.

The rings may have formed from particles around the planet that failed to accrete into a single substantial moon, or they may be debris created from a moon that disrupted. Because the ring particles are presently in coplanar circular orbits, when they occasionally collide, they do so at relatively low velocities. At these low velocities, substantial fragmentation is unlikely, and it seems possible that the particles could stick together and accrete into a moon. The reason they have not is because in orbits close to a planet, the difference in the gravitational pull by the planet on the nearside and the farside of such a moon would be great enough to tear the moon apart. These gravitational tugs are called tidal forces and although they cannot pull apart small, tough objects such as rocks and orbiting spacecraft that are held together by chemical bonds, they can disrupt a liquid moon or a zero-strength conglomeration of rocks and dust bound together only by gravity.

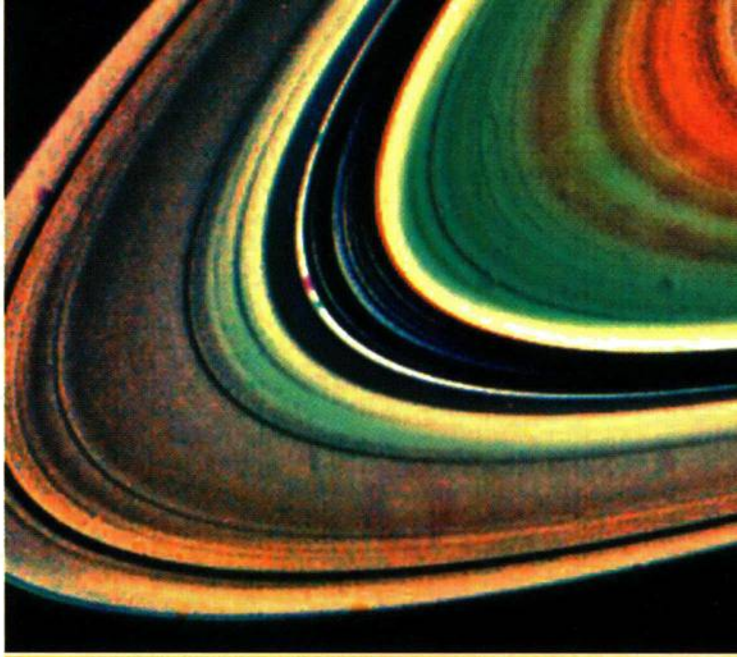
The distance at which the tidal forces will disrupt a liquid moon is approximately 2.5 planetary radii from the center of the planet. Most planetary rings are within this tidal stability limit, which is often called the "Roche Limit" after the French astronomer Édouard Roche, who first calculated this effect.

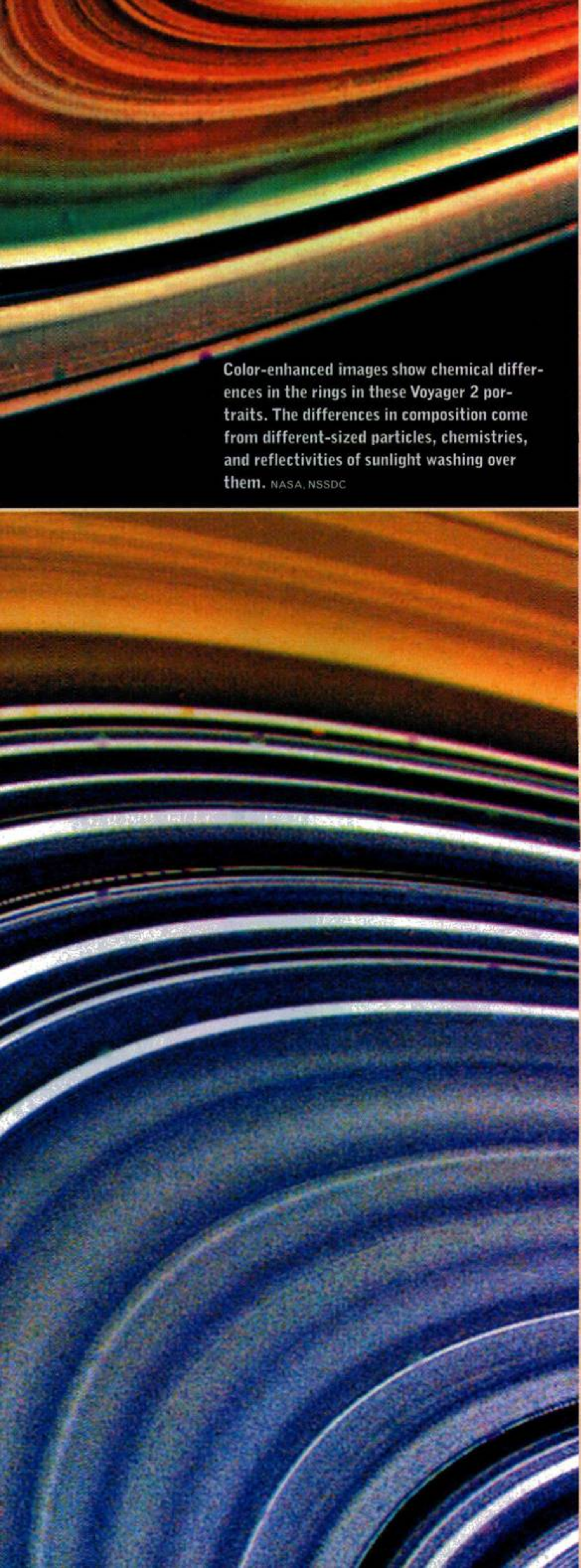
At Home in the Rings

Further advances in our understanding of the nature of Saturn's rings were made in the late 20th century. In 1970 Earth-based infrared spectroscopy revealed that the rings were made mainly of water ice. In 1973 radar signals reflected off the ring particles showed that, on average, they are a few tens of inches in diameter. Close-up views of the rings were made by Pioneer 11 in 1979 and by Voyager 1 and 2 in 1980 and 1981. The rings were imaged in stunning detail, revealing several surprising features including the observation that some ring particles are at least as big as a house.

Each of the rings was found to be composed of numerous ringlets. Five bands of ringlets flanked by dark gaps occur within the Cassini Division. The Encke Division has unusual ringlets that vary in thickness from one place to another. Although most rings are circular, there is a narrow eccentric ring close to Saturn, inside one of the gaps in the C ring. This ring is composed mainly of small particles revolving around Saturn in the same eccentric orbit. Some 2,500 miles (4,000 kilometers) beyond the outermost major ring (the A ring) is the F ring; this unusual ring varies in thickness from 20 to 310 miles (30 to 500 kilometers) and appears to be composed of

For an interactive tour of Saturn's rings,
visit www.astronomy.com





Color-enhanced images show chemical differences in the rings in these Voyager 2 portraits. The differences in composition come from different-sized particles, chemistries, and reflectivities of sunlight washing over them. NASA, NSSDC

several small intertwined ringlets. The peculiar braided structure of the F ring is caused by the gravitational tugs of two small moons, Pandora (60 miles/90 kilometers in diameter) and Prometheus (70 miles/113 kilometers), one on each side of the ring. Because the moons herd the ring particles and control their movements, they have been likened to two sheepdogs herding sheep and are called shepherding satellites.

A ring particle orbiting Saturn just inside the orbit of a shepherding moon goes faster than the moon and can overtake it. As it closes in on the moon, the moon's gravity accelerates the particle forward. As a consequence of this increased velocity and the law of conservation of angular momentum, the particle moves into a larger orbit. After passing the moon and achieving a larger orbit, the particle is closer to the moon than it was before the encounter. The shepherding moon's gravity tugs on the particle, giving it a backward acceleration; the particle loses energy and thereby falls into a smaller orbit. The net result of these gravitational nudges is the apparently braided structure of the F ring.

Two unusual rings occur beyond the F ring. The outermost ring is the 186,000-mile (300,000-kilometer) -wide E ring, stretching between the orbit of Mimas at three Saturn radii from the planet's center to just past eight radii. The brightness of the E ring peaks sharply at the orbit of Enceladus at 3.95 Saturn radii. Ring particles consist mainly of micrometer-size blue spheroids; these particles are so small that they would be dispersed by solar radiation pressure in a few tens of thousands of years. The rings therefore must have been produced in the relatively recent past. Because the brightness of the E ring peaks at the orbit of Enceladus, it seems likely that the ring particles were derived from this 310-mile (500-kilometer) -diameter moon. The surface of Enceladus is made of water ice; the low bulk density of the moon (1.2 grams per cubic centimeter) indicates that Enceladus contains little besides water and ice. The lack of craters on Enceladus indicates that the surface is no more than a few hundred million years old and is possibly much younger. It seems plausible that liquid water from Enceladus's interior flowed across the surface in the relatively recent past, erasing all preexisting impact features. This water may also be responsible for the E-ring particles. Researchers have speculated that an impact into Enceladus within the past fifty thousand years or so blasted water droplets into space. They would have frozen quickly into ice crystals. The drift of these particles through the Saturnian system produced the broad E ring.

Between the F ring and the E ring lies the G ring, a tenuous 620-mile (1,000-kilometer) -wide band composed primarily of millions of 0.5-millimeter-size particles. Because micrometeoroid bombardment and interactions with plasma in Saturn's magnetosphere would erode the particles in a few thousand years, they must have been injected into this region over this timescale. Although no known moon occurs at this distance (2.8 Saturn radii from the planet's center), a hypothetical source for the G-ring particles would be undetected moonlets, possibly house-size icebergs.

In the words of John Milton, "every shepherd tells his tale." But the complex dynamics of ring particles and the possibility of unknown shepherds around the giant planets also make the tale incomplete. ◼

Alan Rubin is a research geochemist at the Institute of Geophysics and Planetary Physics at the University of California, Los Angeles. Disturbing the Solar System *is his first book.*

IDENTI-VIEW™

PREMIUM GLASS SOLAR FILTERS

- SAFE • HIGH QUALITY
- STRICT CONTROL STANDARDS
- LIMITED LIFETIME WARRANTY

CLASS "A"

Color band - blue. Class "A" filters are made with the same premium quality polished glass and multi-alloy coating as Class "B". An additional steel alloy added to the coating process makes our Class "A" filters extremely scratch and fade resistant. Excellent for visual and photographic use. Light transmission is 1/1000th of 1%.

CLASS "B"

Color band - white. Class "B" filters are made with polished glass and multi-alloy coating. These filters offer great durability and will provide many years of service and enjoyment with normal use. Can be used visually and for photography. Light transmission is 1/1000th of 1%.

CLASS "C"

Color band - red. Class "C" filters are specifically coated to a lighter density (ND-4). They are for photographic use only. This filter is intended for use by professionals and serious hobbyists. Light transmission is 1/100th of 1%.

ORDERING INFORMATION

1. State scope brand and model number, aperture and outside diameter with filter class and price.
2. Make check or money order payable to J.M.B. Inc. All foreign checks must be payable through a U.S. bank.
3. Shipped free within the continental United States. All others add $5.50 Shipping and Handling per filter. Michigan residents add 6% sales tax, allow 2-3 weeks for delivery.

VISA J.M.B. INC. MasterCard

736 Oak Glen Circle • Fall Branch, TN 37656
(423) 348-8883 • FAX (423) 348-6389

ATOMIC TIME

1010 Jorie Blvd. #332 Oak Brook, IL. 60523

Tell time by the U.S. Atomic Clock -The official U.S. time that governs ship movements, radio stations, space flights, and warplanes. With small radio receivers hidden inside our timepieces, they automatically syncronize to the U.S. Atomic Clock (which measures each second of time as 9,192,631,770 vibrations of a cesium 133 atom in a vacuum) and give time which is accurate to 1 second every million years. Our timepieces even account automatically for daylight saving time, leap years, and leap seconds. Accept only the best, most precise, and reliable timepieces in the world, Atomic Time.

Atomic Time 0645R Digital Wall
Stand for desk use
Light/Dark Grey
12 or 24 hr. format
day, date, month
temperature, alarm
10.5" x 7.5"
$29.95

Junghans MEGA Carbon 016/2994
Carbon Fiber case, sapphire glass crystal lens, black leather band, LCD with day & date. Made in Germany. Stylish!
$239.20

Atomic Time W113 Digital
Hour, minute, second, day, date, black polymer case-backlight, alarm & stopwatch. Wtrproof.
$49.95

Atomic Time 12" Arabic Walnut
German engineered wall clock updates time signal once daily. Automatically adjusts for daylight saving time, great gift!
$29.95

1-800-985-8463
www.atomictime.com
30 Day Money-Back Guarantee
Call for our FREE Brochure

All items add $7.95 S/H
IL. res. add 6.75% sales tax

Experience The Largest, Most Complete Optical Supermarket In The World

SAVE UP TO 40%

Scope City

EXPERT HELP

WWW.SCOPECITY.COM

SCOPE CITY LOCATIONS:

SIMI VALLEY, CA
730 Easy Street
805/522-6646

SHERMAN OAKS, CA
14324 Ventura Blvd.
818/789-5805

COSTA MESA, CA
3033 S. Bristol
714/957-6900

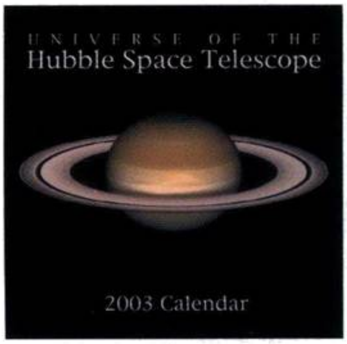
SAN DIEGO, CA
4766 Clairemont Mesa Blvd.
858/277-6686

SAN FRANCISCO, CA
350 Bay Street
415/421-8800

LAS VEGAS, NV
4825 W. Flamingo Rd.
702/947-2673

BUY • SELL • TRADE • SERVICE

Introducing Astrographics' Skywatching Guide


UNIVERSE OF THE
Hubble Space Telescope
2003 Calendar

EARTH from SPACE
2003 Calendar

INTERNATIONAL SPACE STATION
2003 Calendar

Dennis Kunkel's
MICROSCOPIC WORLD
2003 Calendar

New! *Universe of the Hubble Space Telescope* 2003 Calendar

Our all-new *Universe of the Hubble Space Telescope* 2003 calendar now includes our *Astrographics' Skywatching Guide*. This indispensible guide to the night sky provides night-by-night descriptions of sky events, including planet positions and alignments, lunar phases, solar and lunar eclipses, and much, much more. And the calendar features twelve stunning new Hubble Space Telescope images—of galaxies, gaseous nebulae, planets, and more.

Also available (shown at left): *Earth from Space*, *International Space Station*, and *Dennis Kunkel's Microscopic World* 2003 calendars. (Space calendars contain *Astrographics' Skywatching Guide*; microscopic calendar does not.)

12 by 12 inches • 26 pages • $12.95 each

New! Hubble Space Telescope Posters

Hot off the press, the latest images by the Advanced Camera for Surveys, including the Tadpole Galaxy, Cone Nebula, and Omega Nebula.

24 by 36 inches • $11.95 each or full set for $30.00

Also available (not shown):Hubble Space Telescope posters of the Lagoon Nebula, Hubble Deep Field South, and Antenna Galaxies.

24 by 36 inches • $11.95 each or full set for $30.00

Also available (not shown): Anglo-Australian Observatory posters of the Pleiades, Reflection Nebula in Orion, and Galaxy M 83.

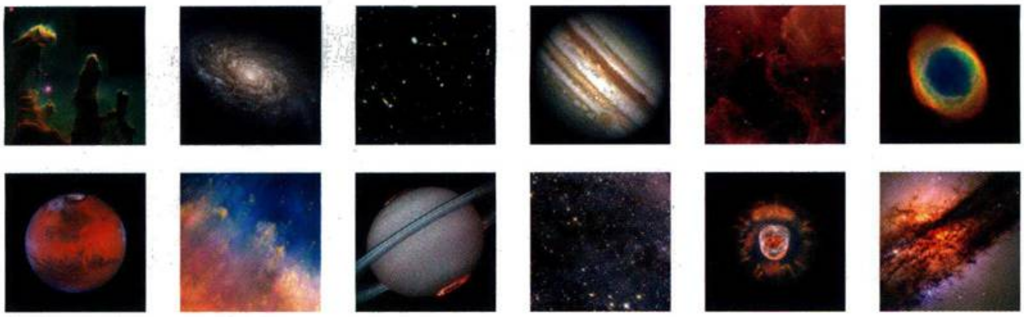
36 by 24 inches • $11.95 each or full set for $30.00

TADPOLE GALAXY
HUBBLE SPACE TELESCOPE

CONE NEBULA
HUBBLE SPACE TELESCOPE

OMEGA NEBULA
HUBBLE SPACE TELESCOPE

Hubble Space Telescope Gallery Prints



Choose from dozens of large-format photographic reproductions of your favorite Hubble Space Telescope images, including the Eagle Nebula, Hubble Deep Field, and many more. Available unmounted or mounted onto a high-density fiber board laminated with crystal-clear epoxy. See our complete selection online.

Unmounted: 20 by 20 inches • $29.95
Mounted: 26 by 26 inches • $119.95

ORDER ONLINE: www.astrographics.com.
ORDER BY PHONE: 1-888-8-ASTRO-8.
QUESTIONS? call1-888-212-7553.
ORDER BY MAIL: Astrographics, 85 Oakside Dr., Smithtown, NY 11787. Shipping and handling: calendars, posters, or logs $3.95 per item category per order; gallery prints $5.95 per order unmounted, $34.95 per item mounted.

astrographics.com

Astronomical Observing Log

Observing Log

Featuring deep-space images by the Hubble Space Telescope, this elegant observing log provides a convenient way to maintain a permanent record of astronomical observations. Includes log pages, notes pages, introductory text, and 28 full-color photographs. A perfect gift!

7.25 by 8 inches • 112 pages • $17.95

sky Show

December 2002

Saturn and Jupiter rise to prominence as the Geminids hit their peak.

by Martin Ratcliffe and Alister Ling

▶ The sky's crown jewel, Saturn, is well placed for observing in mid-evening. On December 17, the Ringed Planet lies opposite the Sun and rises in the east at sunset, hence the term opposition. Its steady yellow ember is at its brightest because the glorious ring system is tilted at its maximum toward us. You may never see Saturn at a better time.

Not far behind, the bright beacon Jupiter — the largest planet — is relatively high in the east by late evening. Eager observers who sneak a peek too early, though, are bound for disappointment from the turbulent view caused by Earth's lower atmosphere. It's always fun to watch shadows on Jupiter's cloud tops, and this month there are some chances to catch pairs of shadows.

The big event this month, if you have tickets in hand, is the total solar eclipse from southern Africa to the coast of Australia on December 4. The next affordable total-eclipse chase is more than three years away across Africa and Asia.

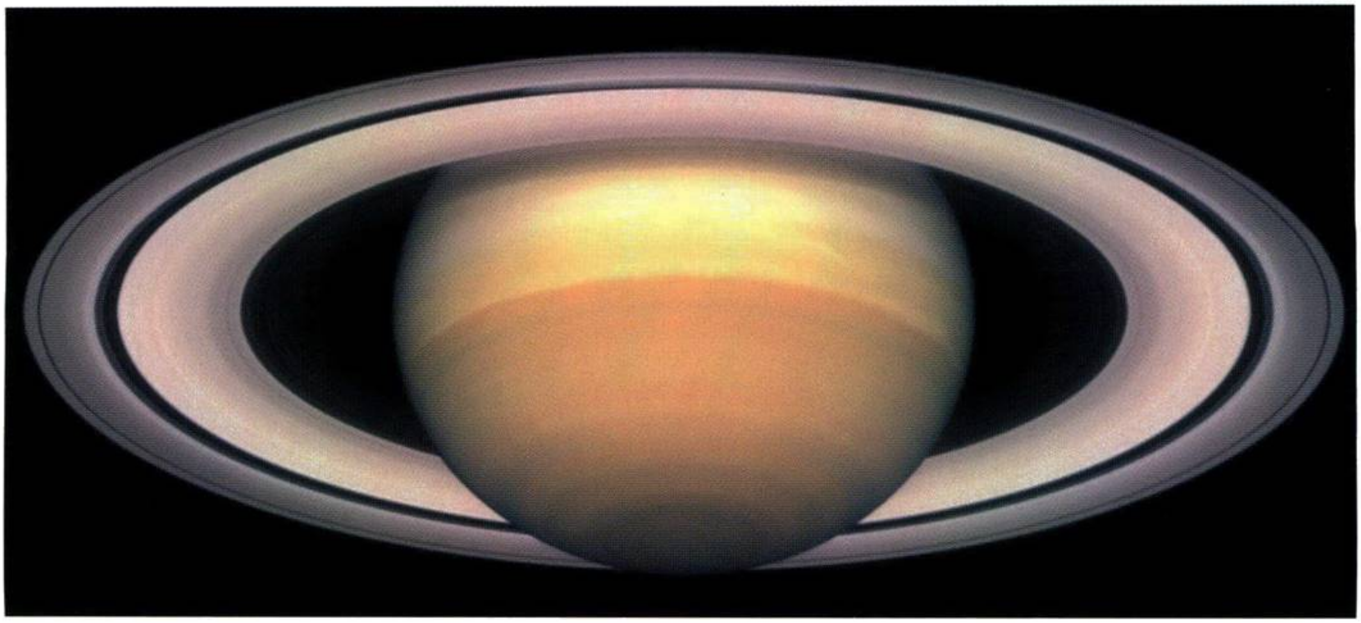
Get ready for a night of bright shooting stars: The Geminids hit their maximum on December 13/14 at 4 A.M. EST. Just before dawn under a dark country sky you'll probably see more than 80 meteors per hour. This may seem like a mere drizzle compared to the roaring Leonids last month, but as one of the year's best, the Geminids offer a good consolation if you were clouded out of the action in November.

Meteors occur when cometary dust slams into Earth's upper atmosphere — the Geminids typically burn up at a fiery rate of 22 miles per second (35 km/s). The dust that causes the Geminids is denser than that of other meteor showers and, consequently, yields lots of bright streaks and trains visible in binoculars.

Mercury returns to the evening sky toward the end of the month. The speedy little inner planet appears surprisingly bright if you haven't seen it before. The trick is to use binoculars and scout the sky at the right time in the right place. You're lucky in that there are no nearby stars bright enough to steer you astray.

Early risers looking east about 6 A.M. local time will already be familiar with the brilliant morning star — our sister planet Venus. But this month, there's something new. If you're wondering what the nearby orange star is, surprise — it's Mars. All month, the fainter rusty fleck floats in the same binocular field as the blazing white Venus. Note the contrast between ruddy Mars and blue-white Spica to its upper right. The crescent Moon adds a touch of class on the mornings of the 1st and 30th. Observers in Japan on the 30th can witness the Moon move in front of Mars.

Winter in the Northern Hemisphere officially begins on December 21 at 8:14 P.M. EST, though in many places the snow has already settled in. The solstice marks the shortest day of the year, when the Sun reaches its southernmost point in the sky among the now invisible stars of Sagittarius. The brilliant stars of Orion and Sirius begin to rise at sunset — mute testimony to winter's upcoming reign.



Saturn appears bigger and brighter than at any time in the past 30 years. NASA and the Hubble Heritage Team (STScI/AURA)

2002

December

1 The Moon passes 3° north of Mars, 5 A.M. EST (page 63)
The Moon passes 2° north of Venus, 8 A.M. EST (page 63)
Asteroid Dembowska is at opposition, 9 P.M. EST (page 65)

2 The Moon is at perigee (225,116 miles from Earth), 3:51 A.M. EST

4 New Moon is at 2:34 A.M. EST; total solar eclipse
Jupiter is stationary, 4 P.M. EST

6 Venus is at greatest brilliancy (magnitude –4.7), 8 P.M. EST

8 The Moon passes 5° south of Neptune, 3 A.M. EST

9 The Moon passes 5° south of Uranus, 9 A.M. EST
Pluto is in conjunction with the Sun, noon EST
Asteroid Massalia is at opposition, 10 P.M. EST

11 First Quarter Moon is at 10:49 A.M. EST

13 The Moon is at apogee (251,602 miles from Earth), 10:56 P.M. EST
Geminid meteor shower peaks

17 Saturn is at opposition, noon EST (page 62)

19 The Moon passes 3° north of Saturn, 10 A.M. EST
Full Moon is at 2:10 P.M. EST

21 Winter solstice is at 8:14 P.M. EST

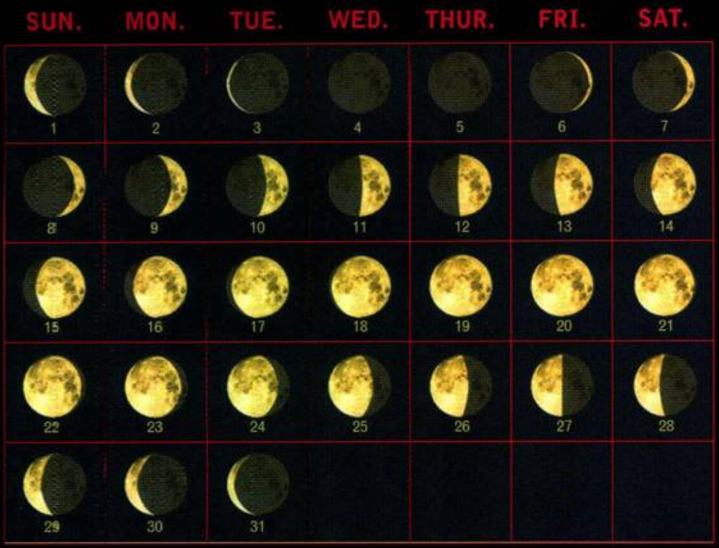
23 The Moon passes 4° north of Jupiter, 7 A.M. EST

25 Mercury is at greatest eastern elongation (20°), midnight EST

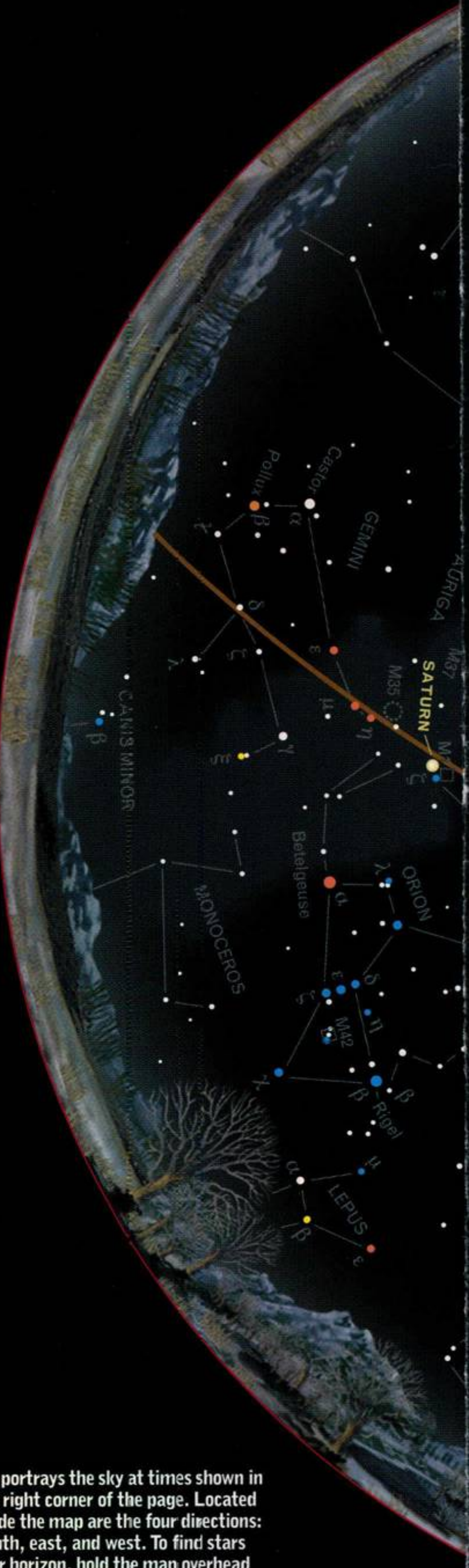
26 Last Quarter Moon is at 7:31 P.M. EST

29 The Moon passes 1.2° north of Mars, 8 P.M. EST
The Moon is at perigee (228,604 miles from Earth), 8:06 P.M. EST

30 The Moon passes 2° south of Venus, 4 A.M. EST


SUN.
MON.
TUE.
WED.
THUR.
FRI.
SAT.
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31

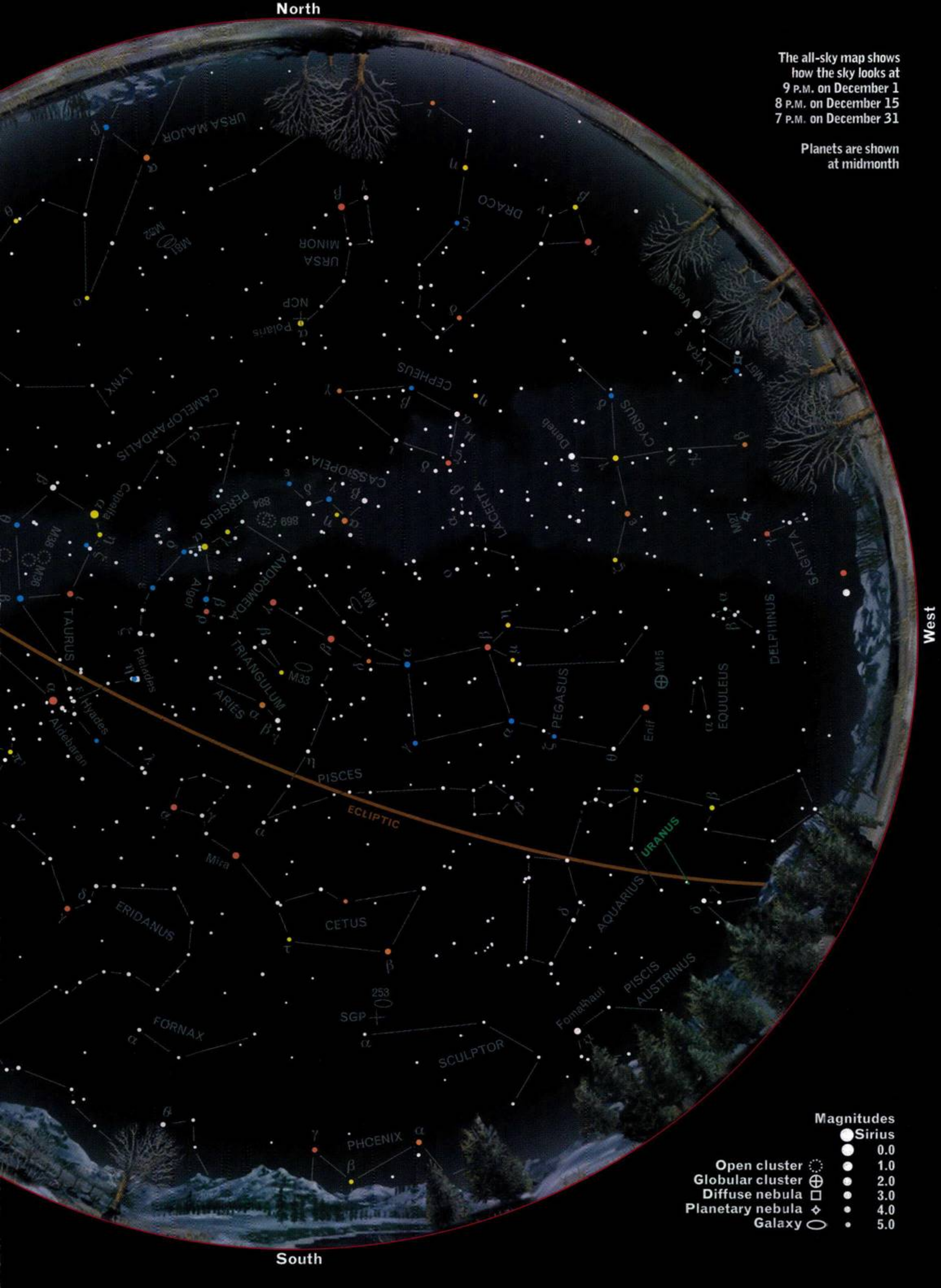
East


Pollux
Castor
GEMINI
AURIGA
SATURN
M35
M37
CANIS MINOR
Betelgeuse
ORION
MONOCEROS
M42
Rigel
LEPUS

This map portrays the sky at times shown in the upper right corner of the page. Located just outside the map are the four directions: north, south, east, and west. To find stars above your horizon, hold the map overhead and orient it so a direction label matches the direction you're facing. The stars above the map's horizon now match what's in the sky.

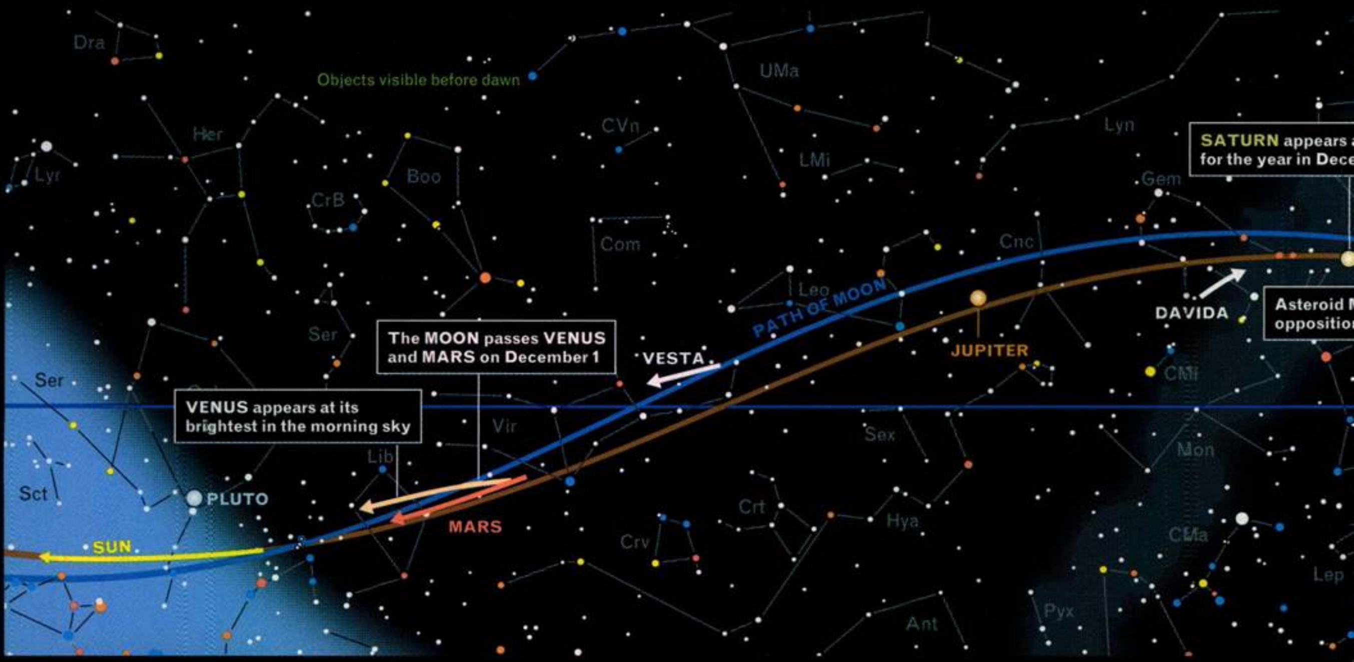
The all-sky map shows
how the sky looks at
9 P.M. on December 1
8 P.M. on December 15
7 P.M. on December 31

Planets are shown
at midmonth


North
West
South
URSA MAJOR
M81
M82
DRACO
URSA MINOR
NCP
Polaris
LYNX
CAMELOPARDALIS
CEPHEUS
CASSIOPEIA
CYGNUS
Deneb
Vega
LYRA
M57
PERSEUS
869
884
Capella
M36
M38
Algol
ANDROMEDA
M31
LACERTA
SAGITTA
M27
DELPHINUS
M15
PEGASUS
Enif
EQUULEUS
TRIANGULUM
M33
ARIES
Pleiades
Hyades
Aldebaran
TAURUS
PISCES
ECLIPTIC
URANUS
Mira
CETUS
ERIDANUS
AQUARIUS
PISCIS AUSTRINUS
Fomalhaut
253
SGP
FORNAX
SCULPTOR
PHOENIX
Magnitudes
Sirius
0.0
1.0
2.0
3.0
4.0
5.0
Open cluster
Globular cluster
Diffuse nebula
Planetary nebula
Galaxy

Path of the Planets

This map unfolds the entire night sky from evening (at right) until sunrise (at left). Arrows and squares show the movements and locations of solar system objec


Dra
UMa
CVn
Lyn
Her
Lyr
LMi
Boo
CrB
Gem
Com
Cnc
Leo
PATH OF MOON
Ser
VESTA
JUPITER
DAVIDA
CMi
Ser
Vir
Sex
Mon
Lib
Sct
PLUTO
MARS
Crt
Hya
CMa
SUN
Crv
Lep
Pyx
Ant

Objects visible before dawn

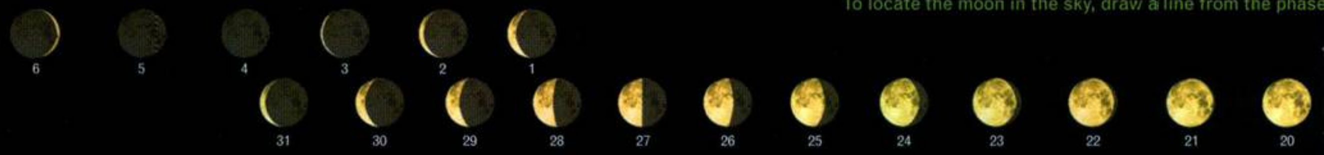
SATURN appears a
for the year in Dece

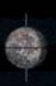
The MOON passes VENUS and MARS on December 1

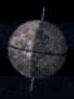
Asteroid M
opposition

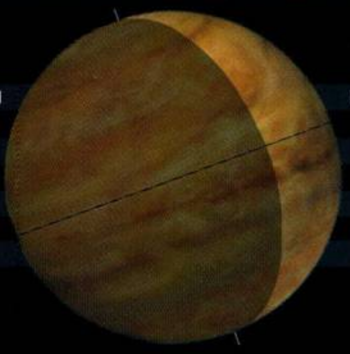
VENUS appears at its brightest in the morning sky

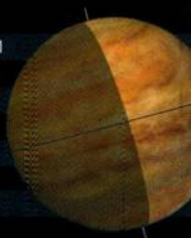
To locate the moon in the sky, draw a line from the phase


6
5
4
3
2
1
31
30
29
28
27
26
25
24
23
22
21
20





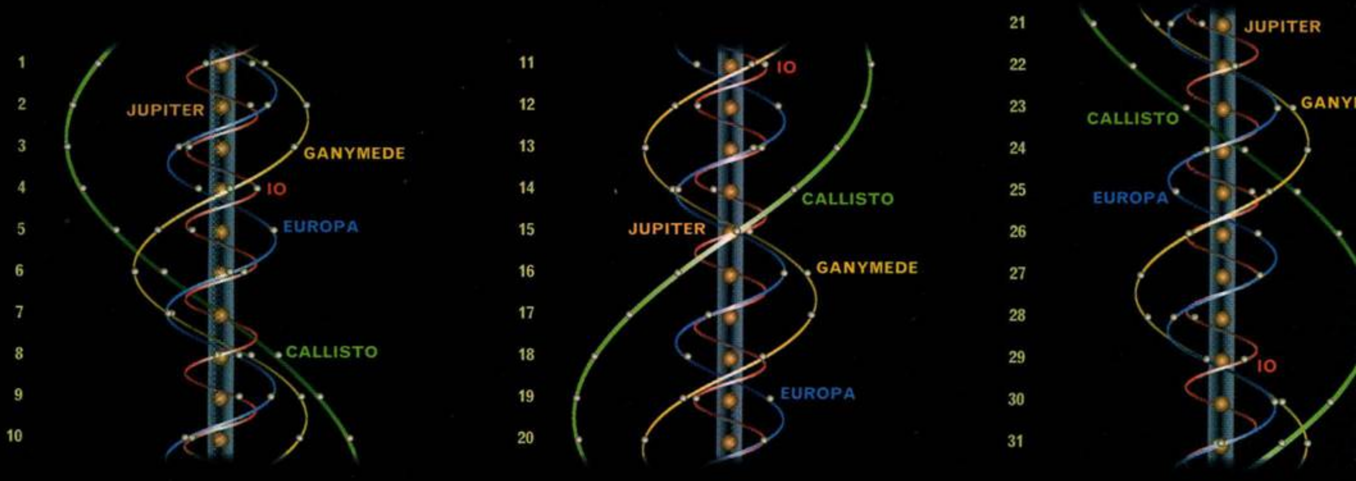




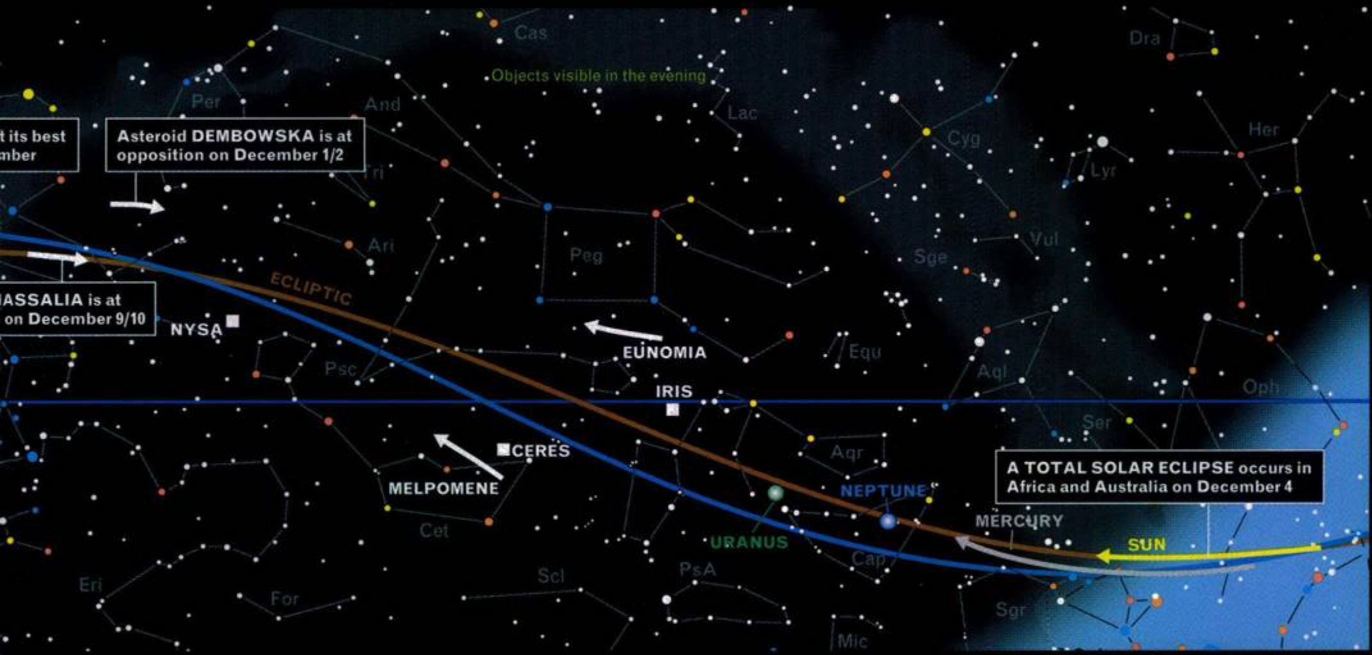
PLANETS	MERCURY	MERCURY	VENUS	VENUS
Date	December 15	December 31	December 1	December 31
Magnitude	–0.6	–0.1	–4.7	–4.5
Angular Size	5.4"	7.7"	44.1"	28.3"
Illumination	86%	41%	21%	44%
Distance (AU) from Earth	1.235	0.874	0.378	0.590
Distance (AU) from Sun	0.405	0.320	0.720	0.718
Right Ascension (2000.0)	18h40.9m	19h59.7m	14h00.2m	15h24.9m
Declination (2000.0)	–25°24'	–21°04'	–11°02'	–15°01'

Jupiter's Moons

Dots display positions of Galilean satellites at 4 A.M. EST on date shown. South is at top to match the view in a telescope.



ts during the month.


Cas
Objects visible in the evening
Dra
Per
And
Lac
Cyg
Lyr
Her
Tri
Ari
Peg
Vul
Sge
ECLIPTIC
NYSA
Psc
EUNOMIA
IRIS
Equ
Aql
Oph
Ser
CERES
MELPOMENE
Aqr
NEPTUNE
URANUS
MERCURY
SUN
Cet
Cap
PsA
Scl
Eri
For
Sgr
Mic

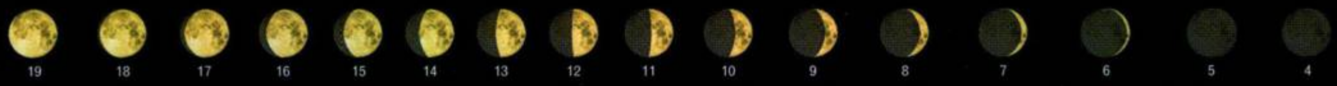
t its best
mber

Asteroid DEMBOWSKA is at opposition on December 1/2

ASSALIA is at
on December 9/10

A TOTAL SOLAR ECLIPSE occurs in Africa and Australia on December 4

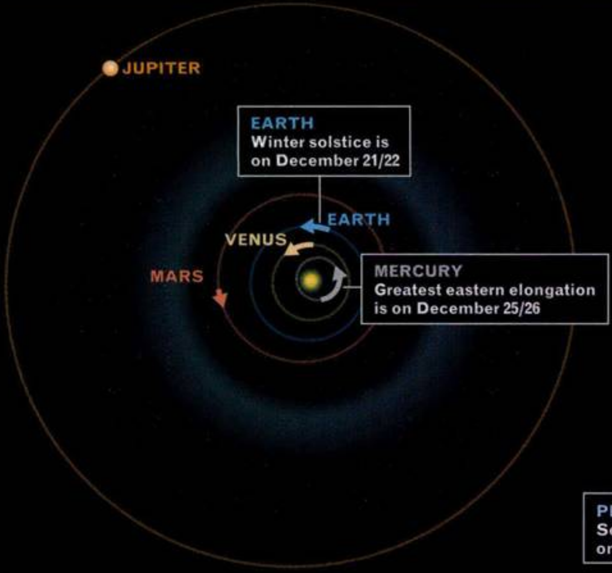
shown for the day straight up to the curved light-blue line.


19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4

MARS	JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
December 15	December 15	December 15	December 15	December 15	December 15
1.6	–2.4	–0.5	5.9	8.0	13.9
4.3"	42.2"	20.6"	3.4"	2.2"	0.1"
95%	99%	100%	100%	100%	100%
2.185	4.671	8.053	20.445	30.758	31.556
1.631	5.296	9.036	20.014	30.085	30.589
14h25.9m	9h22.2m	5h41.8m	21h52.3m	20h45.7m	17h09.6m
–13°36'	16°09'	22°03'	–13°41'	–17°58'	–13°42'

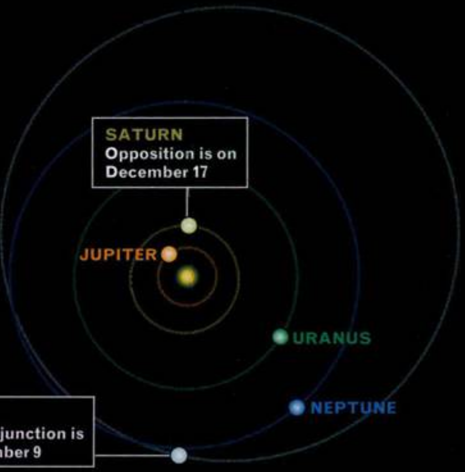
The Planets in Their Orbits

Arrows and dots show planets' positions during the month.


JUPITER
EARTH
VENUS
MARS

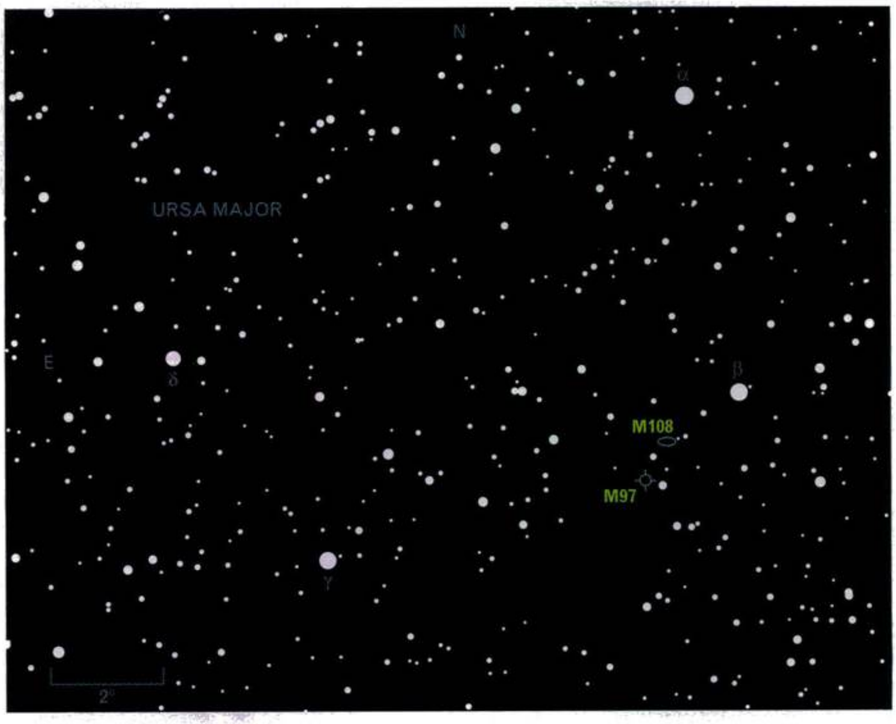
EARTH
Winter solstice is on December 21/22

MERCURY
Greatest eastern elongation is on December 25/26


JUPITER
URANUS
NEPTUNE

SATURN
Opposition is on December 17

PLUTO
Solar conjunction is on December 9



The Owl and the Cigar

As if 25 years ago was last week, the view of the Owl Nebula is still sharp and fresh in my mind's eye. With my 4.5-inch Tasco reflector, I knew I had either discovered a comet or found the Owl. It just couldn't be the nebula, I thought, because it was supposed to be one of the toughest objects in the Messier catalog to see. But with further observation I knew M97 sure wasn't a comet.

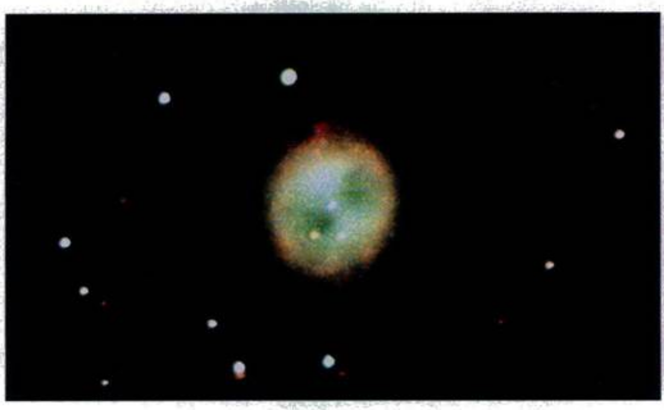
What I saw is emblazoned in my memory: a slightly offset baseball diamond with the nebula at home plate. A telltale photograph at our club's observatory quickly confirmed that it was the planetary nebula, nestled just below the bowl of the Big Dipper. These ethereal planetaries are actually giant clouds of gas exhaled by a dying star, but in a small telescope they often resemble ghostly cousins of gas giant planets.

The lesson I took with me from this incident of astronomical mistaken identity was that you can't always trust a guidebook's description. I think you'll find that the large dark eyes that give the nebula its name are a challenge even in larger telescopes. From the suburbs I've been able to just barely see the Owl in a 4.5-inch scope, but a high contrast filter makes it much easier.

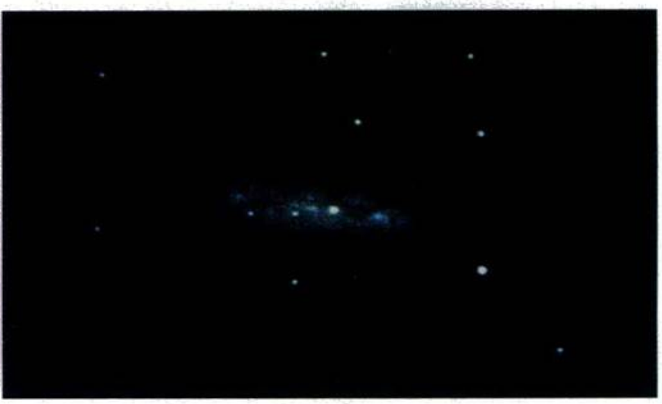
Just before this writing, the Owl's low-power neighbor — the edge-on, starburst galaxy M108 — was invisible through a veil of light pollution. But with good skies and patiently acquired observing skill, there is a lot to see in M108. At first I picked up at 35x what I thought was the stellar nucleus of the cigar-shaped object. But after bumping the power up to 145x in my 4.5-inch scope, I noticed the star is not actually at the center of M108, so it's more likely a foreground object. Carefully using averted vision — the trick observers use to better capture faint objects — M108 appeared brighter in the middle next to a darker patch with another lighter blob on the following side.

If you get a chance to see M108 in a large scope, don't miss it. The surface detail begins to pop out as the mottled texture becomes increasingly defined. The darker patches are caused by an enormous amount of dust blocking radiation from the core, electrified by hundreds of supernovae.

M108 is a starburst galaxy, yet no power-producing supernova has been seen within it. When a massive star runs out of fuel, it collapses and blows itself apart with an energy output rivaling the radiative emissions of its entire parent galaxy. But the dust enshrouding this particular edge-on galaxy is so thick that even a prodigious intensity of light is absorbed. With a bit of luck, though, a supernova may line up with a clearing in the dust to give observers a treat.



Two dark, circular patches give the Owl Nebula its nickname. James McGaha

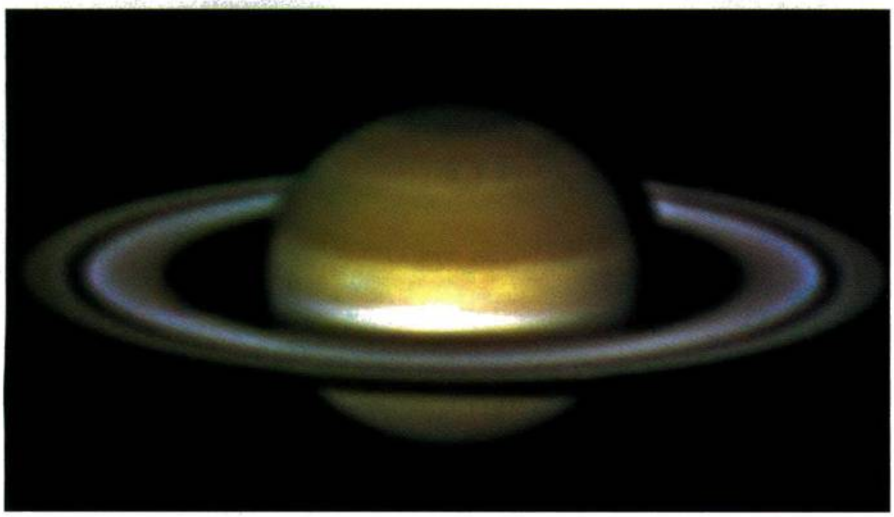


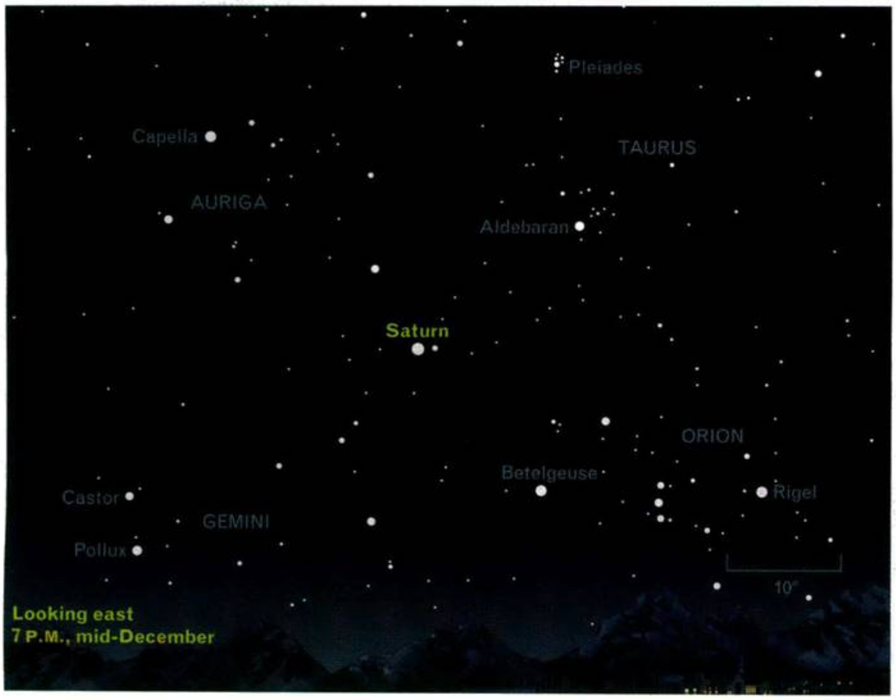
The edge-on spiral galaxy M108 is experiencing a burst of star formation. David Ratledge

sky Show

In December, Saturn reaches its best opposition since the early 1970s. It is now brighter than it's been in years, shining at magnitude –0.5. That means it outshines all the stars in the sky except Sirius the Dog Star, which shines a full magnitude brighter, and Canopus, which lies deep in the southern sky. Jupiter also joins the winter planetary feast, rising in the eastern sky in late evening. By the middle of December, the fluttering streaks of the Geminid meteor shower should appear. The shower's radiant lies midway between the two giant planets. So there are astronomical events all month to capture the imagination and pique curiosity.

Saturn's rings now tip wide open, making details easier to see. Subaru Telescope, NAOJ





Before you turn your scope to Saturn, do a final check on **Uranus** as soon as the sky darkens. At magnitude 5.9, it's easy to find even with binoculars. It glows to the north of Deneb Algedi, or Delta (δ) Capricorni. This month Uranus lies quite close to the 5.1-magnitude star Mu (μ) Cap. Later in December the gas giant falls lower in the western sky and gets lost in the evening twilight.

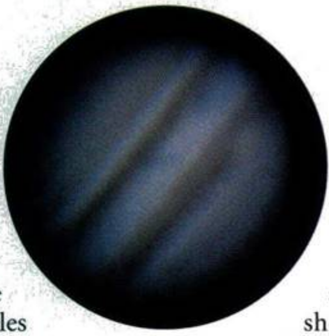
Once Uranus falls from view, turn to the opposite side of the sky to catch **Saturn** sitting above the eastern horizon. From night to night throughout the month, you can track the planet's motion as it moves toward Zeta (ζ) Tauri, one of the "horns" of Taurus the Bull. By the end of December, Saturn lies within the same field of view as the Crab Nebula (M1). It will cross in front of the nebula in early January.

The opposition date for Saturn is December 17. By definition, Saturn then lies exactly opposite the Sun in the sky, and so appears due south at local midnight. The planet is also eight months away from perihelion, its closest approach to the Sun. Consequently, Saturn appears at its brightest both this year and next.

Saturn's disk also appears at its largest at opposition, spanning 21". The rings extend this girth to 47" along their major axis. The minor axis of the rings varies in width throughout Saturn's orbit around the Sun, depending on our viewing angle. Sometimes disappearing when they're edge-on, the rings' minor axis currently spans 21", the maximum possible when viewed from Earth.

An opposition with Saturn at a relatively close 748.5 million miles from Earth is a good time to catch some saturnian satellites. Titan is the brightest at magnitude 8.3, and may be spotted orbiting Saturn nearly twice this month. During the first few days of December, Titan passes south of the planet. Then for a period of three to four days each following its southern passage, you'll find Titan first to Saturn's east, then north, west, and back to south again, a cycle repeating every 16 days.

This month you can watch one of the moons fade as it orbits Saturn. Iapetus varies in brightness on each orbit. This unusual moon appears at magnitude 10.2 when west of the Ringed Planet and magnitude 11.9 to its east. During December Iapetus travels from the west of Saturn on December 1, when it shines at its brightest, to the east of the planet by year's end, dimming as it goes. See if you



With Jupiter now approaching opposition, look for ever-increasing details in its cloud belts. Kim Zussman

can detect the fade. The change in brightness results from half of Iapetus being much darker than the opposite hemisphere. Iapetus orbits Saturn with the same face pointing toward the planet, just like our Moon does as it circles Earth. Consequently, the hemisphere we see of Iapetus constantly changes during its orbit.

Other moons within reach of 6-inch scopes (some with smaller scopes) are Tethys, Dione, and Rhea, in order of increasing distance from the planet. They shine at magnitude 10.2, 10.4, and 9.7, respectively. With an 8-inch scope, Mimas, glowing at magnitude 12.9, should be visible under good sky conditions. Of all saturnian satellites visible in amateur scopes, Mimas lies closest to the Ringed Planet.

In early December **Jupiter** appears over the eastern horizon after 10 P.M. local time for observers near a latitude of 40° north. By midnight it stands clear of the horizon, which enables reasonably good views through a telescope. Above Jupiter lies the pair of stars Castor and Pollux in Gemini the Twins. They rise two hours before Jupiter. By the end of the month, things improve for early evening viewing because Jupiter rises more than two hours earlier.

At magnitude –2.4, Jupiter outshines Saturn, and scintillates like a stunning jewel between the constellations Leo and Cancer. Even nearby Regulus — one of the four 1st-magnitude stars along the ecliptic — appears dim in comparison.

During December Jupiter's apparent diameter grows by nearly 10 percent, reaching 44" across on the 31st. The planet's apparent size will continue to grow until it reaches opposition this coming February. During the next four months, the best of this gas giant is on display. During the long, dark hours of winter nights the entire globe of Jupiter can be observed in one night; it rotates in less than 10 hours.

Begin observing Jupiter as soon as it climbs to a decent altitude. Small telescopes will reveal the major features of the jovian atmosphere: the equatorial belts, the Great Red Spot, and dark spots. Larger scopes will show more subtle features like the delicate, fine-structured belts, smaller spots, and festoons. Check the planet every 30 minutes or so and the features will have moved noticeably. Some four hours later the hemisphere visible in the early evening will be on the far side of the planet and you'll enjoy an entirely new hemisphere.

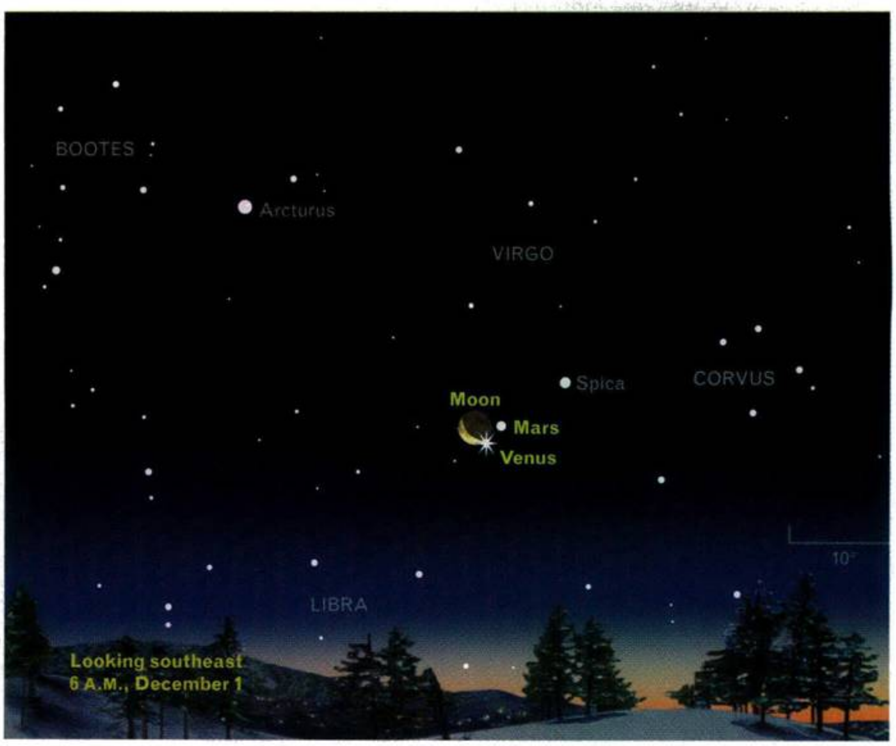
Watching such a parade requires patience, one of the attributes of a good observer. Developing an expert eye for details simply requires practice. You can begin practicing right away. You will find the experience rewarding — even more so if you carefully record what you see.

The relative positions of the jovian satellites vary from night to night, and we see the result as we view their orbits edge-on. Recording this nightly dance reveals which moon is which. Io orbits Jupiter most rapidly, in less than two days, followed by Europa, Ganymede, and Callisto. Callisto takes more than 16 days to orbit the planet once.

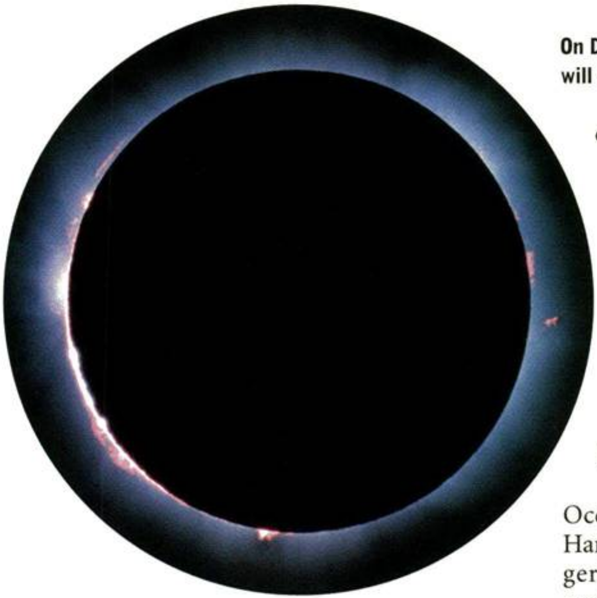
Venus and **Mars** continue their attractive morning conjunction in the predawn sky. A fine crescent Moon joins the pair on December 1. Set your alarm on November 30 for the early morning hours to catch Venus standing 2° south of the Moon. Mars stands just 2° west of Venus. Before dawn the trio shines some 8° east of Spica, the brightest star in the constellation Virgo the Maiden.

Venus glows at magnitude –4.6. With a telescope, follow the fattening crescent as the illuminated portion visible to earthbound observers grows from 21 percent to 44 percent. Simultaneously, the apparent size of the venusian disk shrinks from 44" to 28" as the planet recedes from Earth.

Mars remains diminutive this month, spanning only 4". Few surface details can be seen on such a small disk. Watching it perform a choreographed dance with Venus is certainly the most interesting aspect of the Red Planet during December, as it brightens slightly during the month to magnitude 1.6.



Meteors and Moons



On December 4, parts of Africa and Australia will see a total solar eclipse. Jeffrey C. Buell

Catching Gems

This regular meteor shower peaks over a weekend this year. Conditions should be favorable for North American observers — if skies are clear, of course. Early on the morning of December 14, many bright meteors will streak across the sky. By drawing the trails back along their track, you can identify the position of the radiant. As its name indicates, the shower radiates from a point within the constellation Gemini the Twins.

Conditions are good for the Geminids once the gibbous Moon sets, shortly after 1:30 A.M. local time on December 14. With the radiant high in the sky, large numbers of meteors should be visible. The expected hourly rate if the radiant were directly overhead in a pitch-black sky is 120 meteors per hour. Actual observed rates will be less than this figure. But even lower rates will produce, on average, at least one meteor per minute under ideal conditions. Of course, significantly lower rates occur if you watch from a town or city with significant light pollution, likely cutting the number seen down by at least half of the rate for observers at a dark, clear site. The best place to look is about 50° up from the horizon and at least 40° away from the radiant.

This shower would be as well known as the Perseids if not for its occurrence during the cold winter months. However, if you brave the chill you can expect an exciting night that many less adventurous observers will miss. The peak lasts for quite a long time, with the shower active up to 10 hours on either side of the peak, so most of the world should get a decent show. You can see Geminid stragglers for up to 10 days, from December 7 to 17.

A Lunar Harbinger

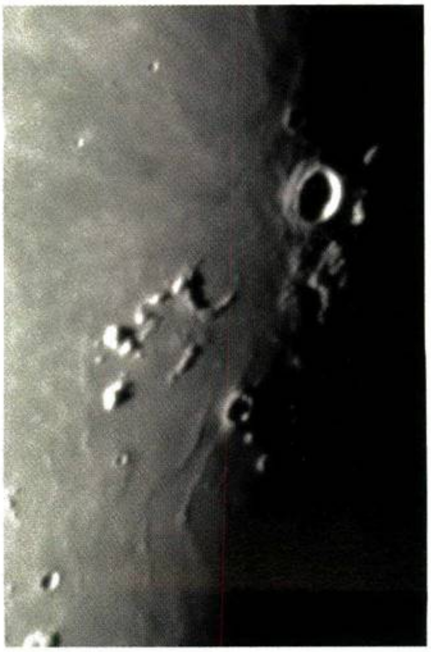
The ancient flooded terrain of Oceanus Procellarum is home to the Harbinger Mountains (Montes Harbinger). This cluster of mountains lies northeast of the brilliant crater Aristarchus. Near the mountains lies the incomplete crater Prinz, a 29-mile-wide crater partly buried by the lava that flooded this region long ago. During sunrise across this area many subtle features, such as domes and rilles, become easily observable under the low-angled lighting. An extended rille runs from the northeastern wall of Prinz out to the west and then turns abruptly north. Aristarchus and Schröter's Valley tend to overshadow this region, but closer scrutiny will offer a look at an almost buried ancient feature of the lunar landscape. Watch for sunrise around the region on December 16.

Into the Moon's Shadow

Few sights match the almost otherworldly beauty of a total solar eclipse. Eclipse chasers often travel great distances for a fleeting glimpse of the Sun's ethereal corona and darkness at midday. Well, unless you live in southern Africa or Australia, it's time to pack your bags.

On December 4 the Moon passes in front of the Sun along a narrow swath that crosses parts of Angola, Zambia, Namibia, Botswana, Zimbabwe, South Africa, and Mozambique. After a long trek across the Indian Ocean, the Moon's shadow touches land again in South Australia. The eclipse ends at sunset near the border between New South Wales and Queensland. Totality lasts at most 1 minute and 32 seconds in Africa, and just 33 seconds in Australia. However, weather prospects favor Australia, where late autumn usually brings hot, sunny, and dry days.

The isolated Harbinger Mountains lie near the prominent crater Aristarchus. David Mansbridge



A Geminid meteor pierces the heart of Orion the Hunter. Mirco Villa

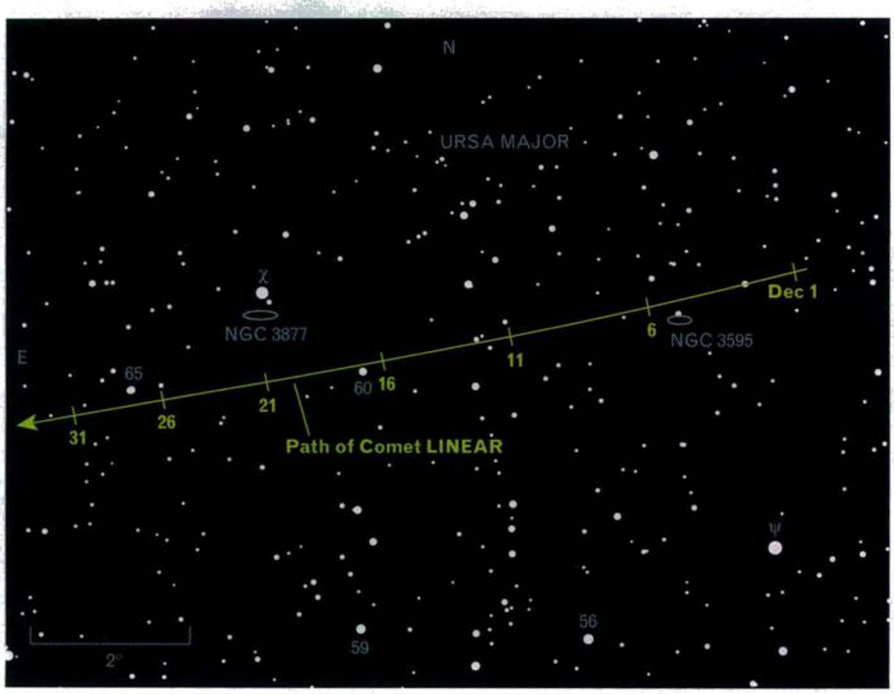
A Fly on the Bear's Back

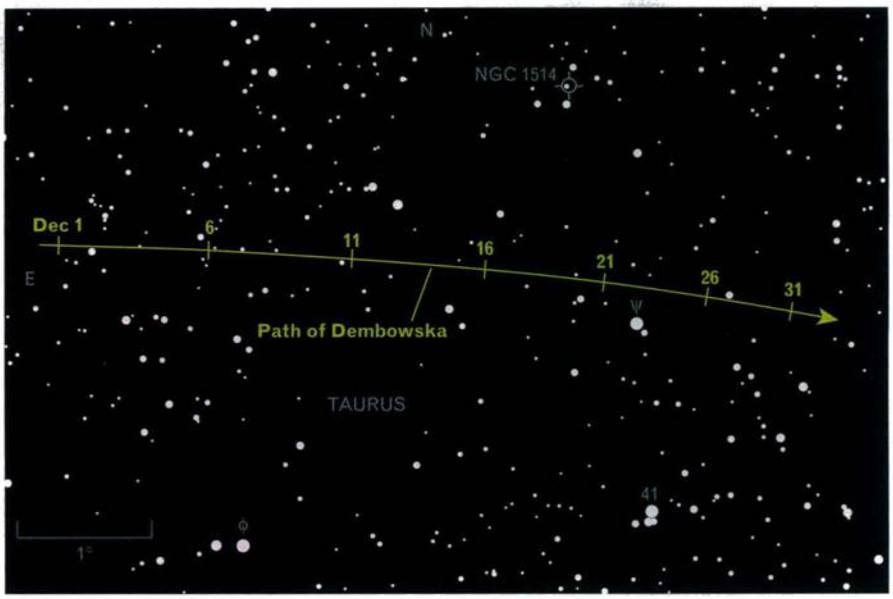
Destined to remain out of the headlines, Comet C/2001 RX14 (LINEAR) will nonetheless provide a nice diversion for galaxy hunters in Ursa Major. Its soft roundish glow should brighten past 11th magnitude, well within reach of a small scope under a dark sky.

With memories of spring's Ikeya-Zhang to keep you warm, pick a dark, moonless night anytime in the first week of December. Because it's so far north, RX14 (LINEAR) is circumpolar, never setting for observers in much of the Northern Hemisphere. However, it grazes the horizon in the evening, so you'll have to wait until at least midnight to have it rise above the horizon murk.

Its path almost parallels the bottom of the Big Dipper's bowl, bringing it close to the modestly bright galaxy NGC 3877 near the bright star Chi (χ) UMa. RX14 (LINEAR) is just 1° south of the galaxy on the nights of December 20 through 22, but the almost Full Moon makes this a lesser event for visual observers.

On the other hand, it's worth getting to know NGC 3877 in its own right. At magnitude 11, this galaxy's long axis spans 5'. Bump up the power because it lies less than one moonwidth south of Chi UMa. On the New Moon weekend of December 6, the comet shares the same low-power field as the 12th-magnitude galaxy NGC 3595. Compare their shapes and textures, and use at least a 6-inch scope unless you want a real challenge.





Asteroid on the Bull's Back

Thanks to its fairly eccentric orbit, the main belt asteroid 349 Dembowska is now much closer to Earth than usual, which means it's brighter than its discovery number would suggest. This month the 10th-magnitude space rock is well within the reach of a small scope from the city suburbs.

Jump up to northern Taurus and the 5th-magnitude star Psi (ψ) Tauri, about a binocular field northeast of the Pleiades. Then use the chart to zero in on the rock, which has a diameter of 90 miles (140 km). With an albedo of 0.34, meaning it reflects 34 percent of the sunlight that hits it, Dembowska is as reflective as Earth and some seven times more so than the Moon.

Because there are a number of background stars of similar brightness, don't jump on the first suspect. Make a quick sketch of the field stars and then come back in a night or two to see which one has moved.

If you have an 8-inch telescope and a high-contrast nebula filter, give the nearby planetary nebula NGC 1514 a shot. It's located not quite 2° north of Psi Tau. If conditions are good, you should see a patchy pale circular disk surrounding a 9th-magnitude central star. Now you know why it's nicknamed the Dew Nebula.

Martin Ratcliffe is President of the International Planetarium Society and observes from Wichita, Kansas. Alister Ling is a meteorologist working for Environment Canada in Alberta.

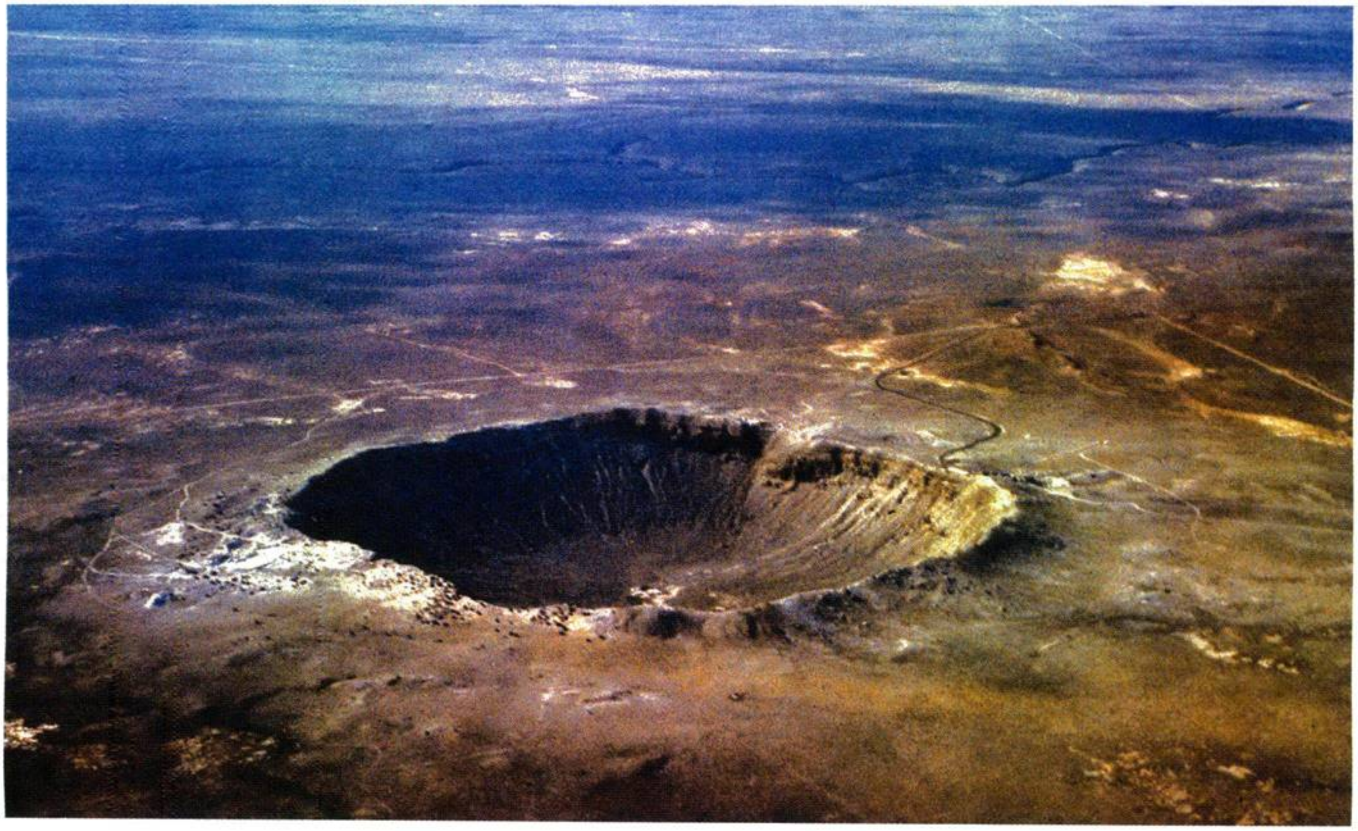
ask Astro

Face on Mars, Faster-Than-Light, Europa's Ocean

Why do I see impact craters with a hexagonal component?

— Cieran George
Sedona, Arizona

A large meteorite hitting a planetary surface strikes at many kilometers or miles per second. In an instant, all velocity stops and its kinetic energy escapes as heat. The result is an explosion that blows rock outward in all directions equally. Only if the meteorite hits the ground at a shallow angle (generally 10° or less above the local surface) will the resulting crater look elongated.



The Barringer Meteor Crater, located in northern Arizona, exhibits a squarish appearance.

D. Roddy/USGS, courtesy of LPI

But, as you note, some craters look hexagonal. What gives?

The Copernicus crater on the Moon is an excellent example because at a quick glance, its rim does look roughly hexagonal. A closer look, however, shows that the "hexagon" comes mostly from many intersecting short segments of rim-wall that run straight for a few kilometers.

Rocks can fragment at 60° and 90° angles, so these segments may be loosely controlled by the way the target rocks fracture in the impact. But the effect may be partly psychological, too. When lit by sunlight, which falls east-west on the Moon, linear segments running north-south tend to stand out and slip easily into eye-catching patterns.

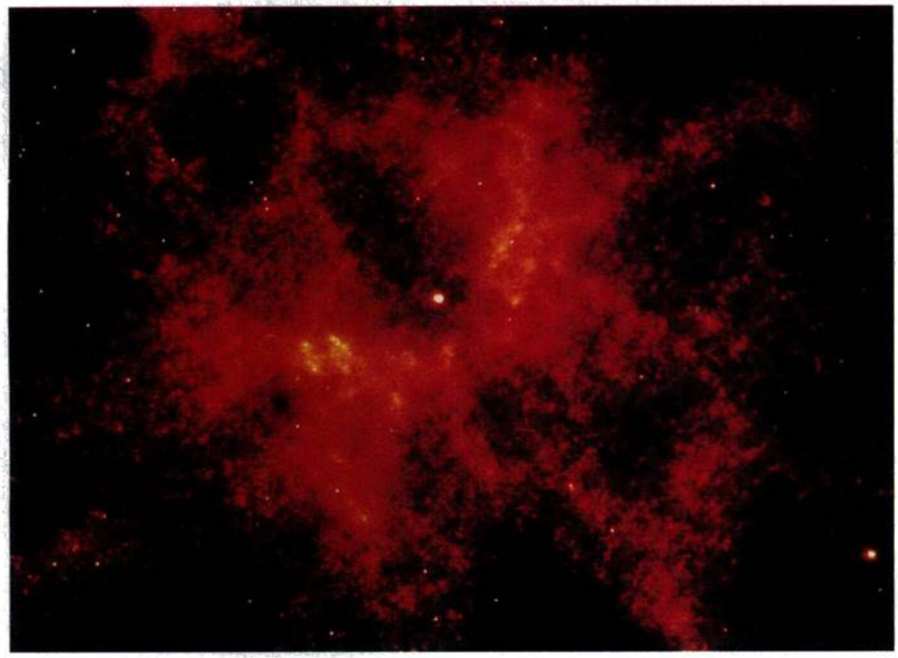
Northern Arizona's Meteor Crater is definitely squarish in aerial photos, and geologist Eugene Shoemaker noted that comes from the cracks, or joints, in the region's rocks. "The diagonals of the 'square' coincide with the trend of the two main sets of joints," he wrote. The impact took advantage of these joints, creating a crater with a squarish outline. Then over the crater's 50,000-year age, the joints allowed erosion to dig more deeply into the rim materials in the directions (NE–SW and SE–NW) where the joints run. — *Robert Burnham, Contributing Editor*

How hot is the universe's hottest star?

— Erik DeWitt
East Haven, Connecticut

You'd think this would have a simple answer, but it depends on whether you mean a normal star, a star that is pulling matter from a companion star, or a white dwarf.

Normal stars generate energy by nuclear reactions. Such stars have a physical limit on how hot, or luminous, they can get. The energy released by the reactions deep in the star ultimately escapes into space. The upward flow of energy within the star produces a physical force



One of the hottest known stars, inside NGC 2440, was captured by the Hubble Space Telescope. The star shines brilliantly with a temperature of 200,000 K.

S. Heap, NASA/Goddard Space Flight Center

that pushes the star's gas outward until it reaches a mechanical equilibrium. That is, the star expands until it cools enough for self-gravity to hold the star together. The more massive the star, the hotter its core will be and the more luminous it will shine — therefore, the larger it will swell before reaching equilibrium.

For a normal star, whose maximum mass is from 60 to 100 times that of the Sun, the maximum temperature is about 50,000 K (90,000° F). What if a more massive star formed? It would run hotter and be more luminous, but the flow of energy would be so powerful that it would tear off the star's outer layers. As this continued, the star would lose mass, begin to run cooler, and become less luminous. Thus, nature sets a limit on how hot a star's surface can be during its normal life — about 50,000 K.

But the story isn't yet over. When the star uses up its nuclear fuel, it loses its thermal energy and internal pressure, and it shrinks. But the contraction makes the surface temperature rise, although the star is no longer generating nuclear energy. At some size the remaining material in the star halts the contraction, and the hot stellar "cinder" simply cools without further structural changes.

This is approaching the white dwarf stage, which happens after the star has shed its outer layers and become a planetary nebula. The pre-white dwarf star in the center of NGC 7027, a very young planetary nebula in Cygnus, has a temperature now of about 150,000 K (270,000° F). But it will cool off over some 100,000 years to about 30,000 K. After a few billion years more, it will lose all its thermal energy and develop a solid core.

For more massive stars, the end is a neutron star. These form immediately after the collapse of a massive star's core and the subsequent supernova explosion that ejects the star's envelope. The surface temperature of a newly made neutron star runs well above 5 million K (9 million° F), but again this doesn't last. Neutrinos and light are emitted at a furious rate and within a few million years the temperature drops below about a million kelvins, and then declines rapidly to about 100,000 K (180,000° F).

The third case is when a star — any kind of star — accretes matter from a companion in a close binary system. Energy is released when material from the companion falls on the surface of the primary star. This can heat the primary's surface layers far hotter than what they might ordinarily reach. For example, a white dwarf or neutron star that had cooled somewhat from its initial state could boost its surface temperature back to a million kelvins or more — and easily sustain this as long as matter continues to fall and compress the surface layers. This heating method operates independently of the star's internal state.

Even a normal star like the Sun, with a surface temperature of 6,000 K (11,000° F), could reach temperatures of around 30,000 K (54,000° F) if it had a companion that was feeding it gas. Lucky for us, the Sun doesn't.

— Steven Shore, professor of astrophysics, Indiana University at South Bend

What is the origin of the 0.965-inch eyepiece size? Is it from the pre-metric age or, as I have heard, from microscopy?

— John L. Jones
Bellwood, Illinois

I posed this question to members of the Antique Telescope Society's "Old Scopes" Internet discussion group. After all, who better to ask than a group of folks who collect telescopes that date back well into the 19th century?

One member chalks it up to an approximation between metric and English units. As he points out, a metric diameter of 24.5 millimeters, which is just a bit under one inch (25.4mm), would convert more precisely to 0.964566829 inch. Rounding this to three decimal places yields 0.965 inch.

Another poster mentions the venerable German optics maker Carl Zeiss offered a line of telescopes fitted with eyepieces of that size as early as the 1890s. As to why they settled on such an unusual size, the definite answer seems to be buried in the recesses of history. Undoubtedly it has a lot to do with the size of oculars used in other instruments of the day, such as microscopes.

Over the years, 0.965-inch eyepieces became synonymous with telescopes imported from Japan. As one ATS member suggests, this could be a manifestation of close trade relationships between Japanese and German optical companies prior to World War II.

One poster summed all this up with, "My guess is that if there is an answer to how 0.965 arose, it will be trivial."

Investigate astronomy's rich optical heritage for yourself by visiting the Antique Telescope Society's website at http://www1.tecs.com/oldscope.

— John Shibley, Contributing Editor

CONTACT INFO

Send your questions via e-mail to: askastro@astronomy.com; or write to: Ask Astro, P.O. Box 1612, Waukesha, WI 53187. Please tell us your full name and where you live.

Shadow Play around Jupiter

Jupiter's four big moons have begun a new series of mutual eclipses and occultations.

by Richard Talcott

AS ECLIPSE CHASERS HEAD SOUTH TO VIEW THE TOTAL SOLAR eclipse on December 4, those left in the Northern Hemisphere may feel slighted. Not to worry. For observers with telescopes, a slew of impressive eclipses will occur over the next several months. No, they won't reveal the Sun's spectacular corona, and no fiery prominences will leap above the pitch-black limb of the Moon. The rewards of observing these events will prove more subtle, though satisfying.

The trick to observing these eclipses is to peer not at the Sun, but in the opposite direction — toward Jupiter. The four large moons of Jupiter — volcanic Io, icy Europa, giant Ganymede, and cratered Callisto — will cast shadows on one another from now until September 2003. As an added bonus, these satellites will pass in front of and behind each other from our earthly perspective.

A year-long extravaganza of hundreds of these events returns every six years, thanks to the geometry of the solar system. Twice during each 12-year-long orbit of the Sun, Jupiter sees both the Sun and Earth pass through the plane of its equator. The Sun passes through that plane in late March 2003, which corresponds to the planet's autumnal equinox, while Earth follows suit in late July.

Because the four big moons orbit Jupiter nearly in its equatorial plane, each satellite can step into another's shadow, creating a mutual eclipse ("mutual" emphasizes the satellites are acting on each other, not on their host planet). In this situation, Earth is not in line with the moons, so observers can usually see both over the event's duration, though the eclipsed moon dims for a time. If, however, one satellite passes directly between another and Earth, it physically blocks its sibling from view in what is known as a mutual occultation. From October 3, 2002, to September 22, 2003, 578 mutual events will take place, with approximately 60 percent being occultations.

Viewing conditions for these events should be nearly ideal. On February 2, Jupiter reaches opposition, when it sits opposite the Sun in the sky and shines brightly all night long. It then lies among the background stars of Cancer. For several months before and after opposition, it hangs high overhead for much of the night from the Northern Hemisphere. Compare that with the 1996 series of mutual events, when Jupiter lay low in the southern sky as it trekked across Sagittarius.

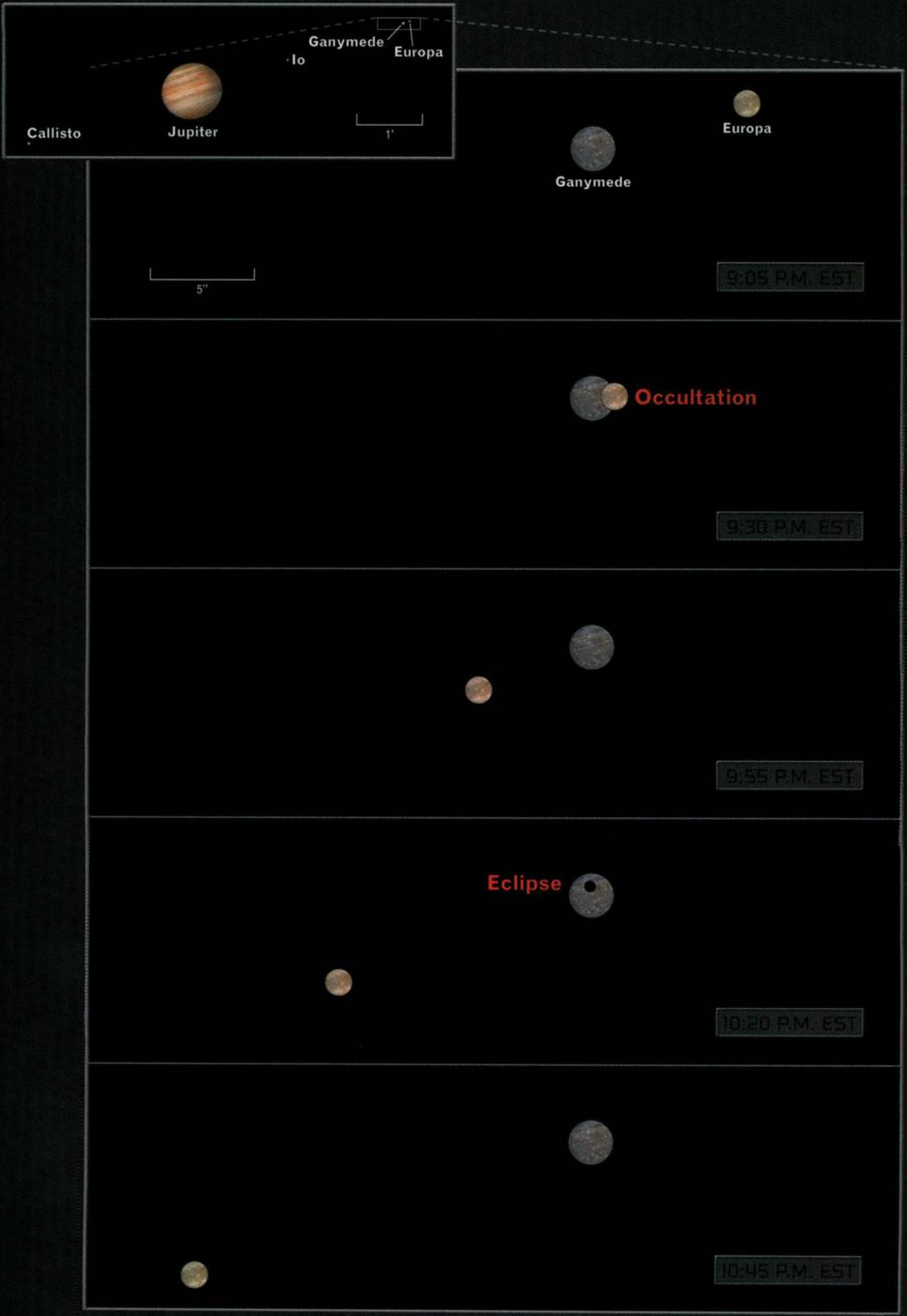
Jupiter's high elevation should minimize problems from turbulence in Earth's atmosphere. Poor "seeing" causes blurry images and grows worse the lower an object appears in the sky because its light must pass through more air. You can reduce this problem by pointing your telescope over terrain that keeps a fairly constant temperature. A large expanse of grass or snow, or a large body of water, works well. Avoid setting up near buildings, paved parking lots, or other surfaces that absorb heat during the day and release it at night.

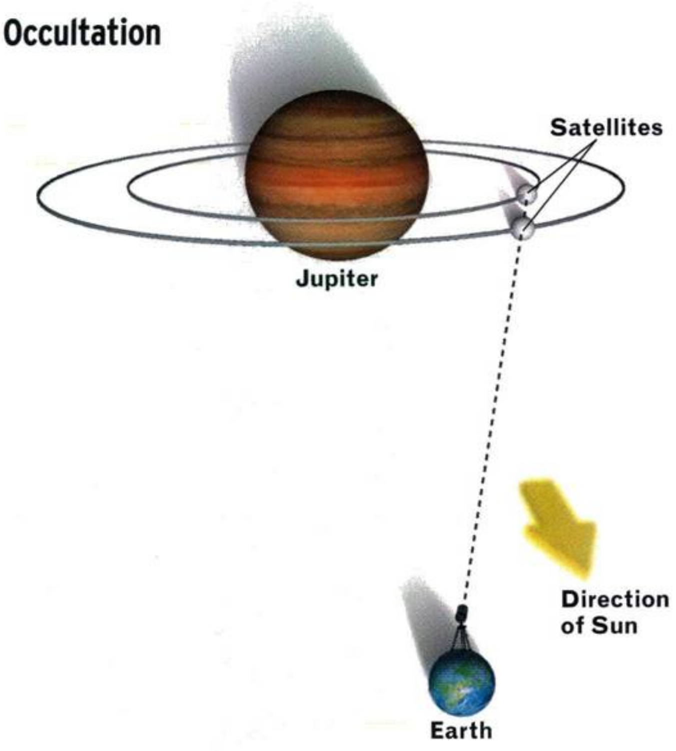
Can't-Miss Events

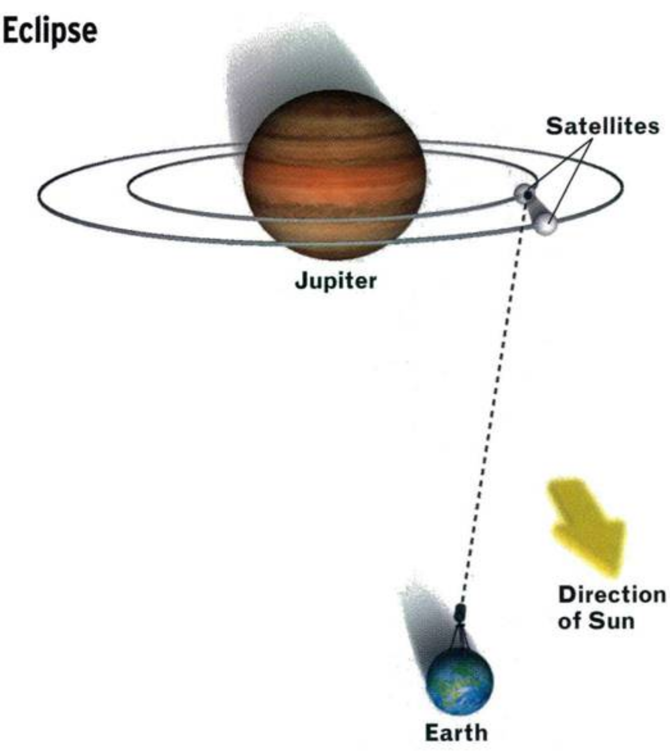
The table on page 72 lists some of the best mutual events for North American observers. (To see an exhaustive list, check out the *Astronomy* magazine page at *Astronomy.com.*) The sheer variety of arrangements is breathtaking — 24 combinations of eclipses and occultations exist, and each of these has three or four variations.

Most are partial events, when one moon or its shadow skims another. An annular event occurs when the moon closer to Earth appears entirely within the disk of the second, or when its shadow appears entirely contained within the eclipsed moon's disk. The most impressive events are total ones, when one moon hides or shades the entire disk of the second.

Twice during its 12-year orbit, Jupiter sees both the Sun and Earth pass through the orbital plane of its four big moons, producing hundreds of mutual events. In one such event, as seen from Ganymede, Jupiter and Io glow nearby while Europa blocks out the Sun. The objects have been enlarged ten times, but their distances are to scale. *Astronomy*: Elisabeth Rowan


Ganymede
Europa
Io
Callisto
Jupiter
1'
Europa
Ganymede
5"
9:05 P.M. EST
Occultation
9:30 P.M. EST
9:55 P.M. EST
Eclipse
10:20 P.M. EST
10:45 P.M. EST





The main difference between an occultation and an eclipse is our vantage point. When Earth is aligned with the moons of interest (left), we see one moon block the other in an occultation.

When the Sun is aligned and Earth is not (right), we see the shadow of one moon fall across the face of another in an eclipse. Mutual eclipses are often subtle, so go out early to locate the active moons. *Astronomy*: Elisabeth Rowan

Aided by the long winter nights and Jupiter's exalted place in the sky for many of them, December offers several good viewing opportunities. One of the best is an annular eclipse of Io by Europa on the evening of December 19. At 11:49 P.M. EST, Europa's shadow will start to impinge on Io, and within four minutes the eclipse will reach maximum. Io's brightness will fade by a whopping 71 percent in those few moments.

The same moons will seemingly merge on the morning of December 22. At 6:08 A.M. EST, Io's disk will make first contact with Europa. Within two minutes, Io will totally block Europa from view, though totality lasts a scant nine seconds. At the time, the pair will appear silhouetted in front of Jupiter's cloudtops. To add to the tableau on this first morning of winter, Earth's moon will appear just 6° from Jupiter.

Right after Jupiter's opposition, on the evening of February 10, Europa and Ganymede will perform a double pas de deux. At 9:29 P.M. EST, Europa will begin to pass in front of the much larger Ganymede. Six minutes later, Europa will lie completely inside Ganymede's disk, and the pair's combined light will dip by 48 percent. In less than an hour, at 10:17 P.M., Europa's shadow will start moving across Ganymede, which will dim by 35 percent at the eclipse's peak four minutes later.

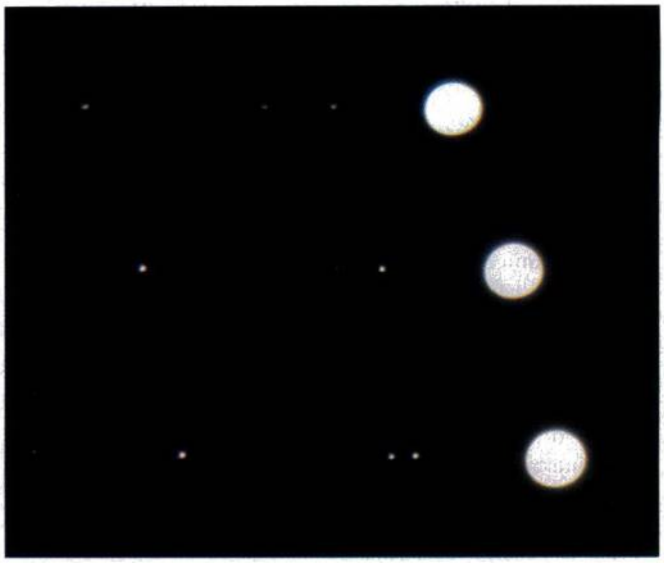
Observing an Event

What you see of a mutual event depends on the size and quality of your telescope as well as the local seeing conditions, though most observers with decent scopes will be able to glimpse something worthwhile. Go out well ahead of time and pinpoint which moon or moons will be involved. That's pretty easy to do for a mutual occultation — simply look for the two moons lying closest together. It's trickier for a mutual eclipse, where you must concentrate on a single moon that may not be near any other. Use the chart in the magazine's center spread to pick out which moon is which.

With a 6-inch or smaller telescope, or with any telescope

On February 10, observers will be treated to both an occultation and an eclipse between Ganymede and Europa. When the smaller Europa steps in front of Ganymede, the duo's combined light will be cut nearly in half. In the eclipse, Ganymede's light will dim by 35 percent. *Astronomy*: Elisabeth Rowan

From left, Ganymede, Europa, Io, and Jupiter were photographed every hour for three hours. In the middle exposure, Europa dims during a partial eclipse by Io, and Callisto is visible in the bottom-left corner. Jim Curry



Mutual Events of Jupiter's Moons

Date	Event	Type	Beginning	Duration	Light Loss	Distance
December 19	Europa eclipses Io	Annular	11:49 P.M.	471	71%	5.7
December 22	Io occults Europa	Total	6:08 A.M.	216	43%	0.3
December 27	Europa eclipses Io	Annular	2:22 A.M.	544	65%	5.8
January 3	Europa eclipses Io	Partial	5:02 A.M.	643	51%	5.9
January 7	Europa eclipses Io	Annular	4:16 A.M.	1,688	71%	0.0
January 14	Europa eclipses Io	Partial	3:28 A.M.	1,874	60%	2.1
February 10	Europa occults Ganymede	Annular	9:29 P.M.	730	48%	9.2
February 10	Europa eclipses Ganymede	Annular	10:17 P.M.	535	35%	9.5
February 24	Io eclipses Europa	Partial	12:34 A.M.	149	71%	0.9
February 28	Io eclipses Callisto	Annular	7:36 A.M.	661	53%	1.4
March 3	Io eclipses Europa	Annular	2:46 A.M.	163	85%	1.0
March 9	Callisto eclipses Io	Annular	2:23 A.M.	175	70%	1.8
March 10	Io eclipses Europa	Annular	4:59 A.M.	166	85%	1.1
March 25	Callisto eclipses Europa	Annular	11:13 P.M.	213	82%	7.3
April 4	Ganymede eclipses Callisto	Annular	12:48 A.M.	378	70%	14.4
April 12	Ganymede eclipses Io	Partial	11:35 P.M.	194	69%	2.8
April 16	Europa eclipses Io	Annular	11:30 P.M.	201	57%	3.3
April 19	Ganymede eclipses Io	Partial	2:20 A.M.	231	86%	3.5
April 24	Europa eclipses Io	Annular	1:45 A.M.	204	65%	3.1
May 1	Europa eclipses Io	Annular	4:01 A.M.	196	65%	2.8
June 7	Ganymede eclipses Io	Partial	11:55 P.M.	739	64%	5.6

Beginning: The start of the event in EST. **Duration**: The length of the event in seconds. **Light Loss**: For eclipses, the percent of light lost at mid-event by the eclipsed moon; for occultations, the percent of light lost at mid-event from the combined light of both moons. **Distance**: The apparent distance of the moon from Jupiter's center in jovian equatorial radii.

when seeing conditions aren't good, all of the moons will appear as unresolved points of light. Even so, it's best to use a fairly high magnification, up to about 30x per inch of aperture. This will make the moons' separation more apparent.

During a mutual occultation, the two moons will slowly approach each other until they're side by side, resembling a single, elongated capsule. This bright image then begins to fade and grow more circular as the nearer satellite blocks out some or all of the farther one. Then, the stages play out in reverse as the hidden moon peeks back into view. Because one moon always stays visible, the loss of light can never exceed about 62 percent.

During a mutual eclipse, focus on the moon being eclipsed — that moon should dim if the projected light loss is 20 percent or greater. One good way to judge the amount of fading is to compare the eclipsed moon's brightness to that of a nearby moon. Io shines at magnitude 5.0, Europa at 5.3, Ganymede at 4.6, and Callisto at 5.6.

Better views await those with larger telescopes, good optics, and steady seeing. With these, expect the moons to appear as small disks rather than points of light. You may even be able to tell that the disks of Io and Europa appear smaller than those of Ganymede and Callisto.

Because Callisto reflects only 20 percent of the sunlight that hits it — less than half of any of the other satellites — occultations will be especially dramatic when this faint moon passes in front of a brighter rival.

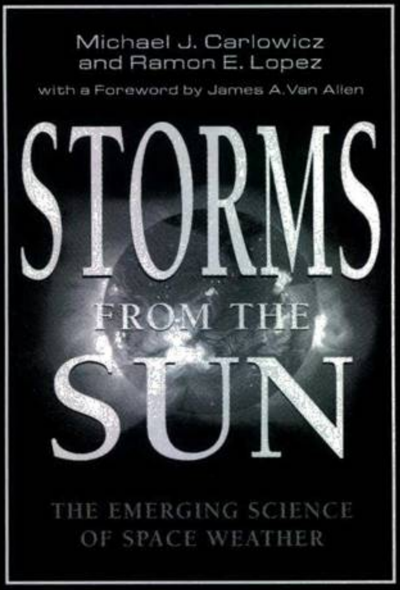
When the shadow of one moon falls on the disk of another in an eclipse, a light drop of less than 20 percent will prove difficult to detect. Anywhere from 20 to 40 percent is borderline; you may have to compare the brightness to the other moons to discern a change. From 40 percent up to about 90 percent, the dimming is obvious. The eclipsed moon will seem to disappear with any amount above 90 percent. As you can see in the table above, however, few eclipses are that striking, so pounce on those opportunities.

As you gaze upon Jupiter and its moons this coming year, remember that the Galileo spacecraft, launched in 1989 to study these objects, will be moving through the same field of view, though it's far too faint to see. It so happens that Galileo and the mutual events share a similar fate — both come to an end in September 2003.

For Galileo, it's really the end of the line — ravaged by searing radiation from the powerful magnetic field around Jupiter, it will plunge into Jupiter's atmosphere, to be crushed under incredible pressure. No such cataclysmic fate awaits the mutual events. Although this series wraps up in September, it's just a short hiatus in the grand scheme of things. As the clockwork movements of the solar system continue, a new series awaits earthbound observers in another six years.

Richard Talcott is Astronomy*'s senior editor. This will mark the fourth series of mutual events he has observed.*

Forecasts call for **SOLAR RUMBLES**
followed by **MASSIVE CORONAL EJECTIONS . . .**



ISBN 0-309-07642-0 • HARDCOVER
248PP. • 6 X 9 • $27.95

"Ten years ago, almost no one had heard of 'space weather.' Now, few of us in the developed world can escape its influence. And no one writes about it with greater flair and clarity than Michael Carlowicz and Ramon Lopez."

—Stephen P. Maran, author,
Astronomy for Dummies® and editor,
The Astronomy and Space Science Encyclopedia

JH

Co-published by the Joseph Henry Press and the Dana Press
www.jhpress.org

At fine bookstores near you

FOR THE LOWEST
PRICES & BEST SERVICES
TO ORDER CALL TOLL FREE!

PHONE ORDERS:
Mon. through Sat. 9-6
Pacific Standard Times

FOR GREAT DEALS GAZE AT OUR WEBSITE
WWW.TELESCOPES.NET

WOODLAND HILLS
Camera &
Telescopes

5348 Topanga Canyon Blvd.
Woodland Hills, CA 91364

telephone: 818-347-2270
fax: 818-992-4486

MEADE

GoTo
Telescope

Meade
7", 8", 10" & 12"
GPS, SCT's & Refractors in stock.

We have the complete line of **Meade** CCD cameras in stock.

FULL LINE MEADE STOCKING DEALER!

ON SPECIAL!

Meade ETX 90 R/A
Trade in your old Maksutov for a new one.

Buy a New
Meade ETX 90 R/A M
$169.00 With 884 Tripod $329.00

CALL US FOR MEADE
FREE TRIPOD SPECIAL

NexStar 8 GPS
$500.00
REBATE

The New NexStar 11
GoTo Telescopes
by Celestron-In stock CALL

TELEVUE
Come see the new
Televue 76

Plossl-50° FREE SHIPPING!
8-11, or 15 .... $82
20 or 25mm $95
Panoptic-68°
15mm $210
19mm $240
Panoptic-58°
35mm $365
Nagler-82°
4.8mm $155
7mm $190
9mm Type 6 .... $280
Nagler type 5 31mm NOW IN STOCK!
3-6mm Zoom $380
8-24 Zoom $180

Call now to Reserve
Your NexStar CM 1400 GT

Last Call

Celestron 8 Telescope
6x30 finder,
R/A Motor wedgepod
.... **$999.00**

Firstscope DS 70 EC **$149.95**
70mm refractor, 700mm focal length, electronic control

CELESTRON
NexStar 8 .... **$1499** *
Includes Dew Shield - FREE Shipping

CELESTRON 1 1/4" EYEPIECES
ULTIMA EYEPIECES
5mm, 1 1/4" $67.95
12.5mm, 1 1/4" $67.95
30mm, 1 1/4" $84.95
42mm 1 1/4" $99.95
7.5 .... $67.95
18mm, 24mm, 1 1/4" $77.95
35mm, 1 1/4" $99.95
Ultima Barlow Short Tube Version $67.95
PLOSSL EYEPIECES
3.6, 6.3, 7.5,13, 10, 17, 1 1/4" $39.95
32, 40mm, 1 1/4" $59.00

1-888-4ASTRONOMY
(1-888-427-8766)

MasterCard American Express Card VISA DISCOVER

Auriga

Within the confines of the Charioteer, the winter Milky Way comes alive with bright star clusters and dazzling nebulae.

by Tom Polakis

Brisk winter evenings might seem the perfect time to curl up with a good book next to a toasty fireplace. Yet to a deep-sky observer, the cozy indoors can't hold a candle to the often crystal-clear skies of the season.

Look straight overhead on these winter evenings and your eyes will land on a stretch of the Milky Way located exactly opposite the galaxy's center. Here the gauzy band appears faintest and shows little of the structure — vast star clouds and dark nebulae — common elsewhere. Like any swath of the Milky Way, however, this region brims with wonderful star clusters and delicate emission nebulae.

The bright foreground stars in this direction belong to the constellation Auriga the Charioteer, which forms a distinct pentagon shape north of Taurus the Bull. Capella stands as the gem of Auriga. Gleaming at magnitude 0.1, it ranks as the sky's sixth brightest star. This yellow star has a color similar to the Sun's, but it's a superstar in comparison. The Sun would barely be visible to the naked eye if it were at Capella's distance of 42 light-years. To the east, Theta (θ) and Beta (β) Aurigae make a great pair of pointer stars to Polaris.

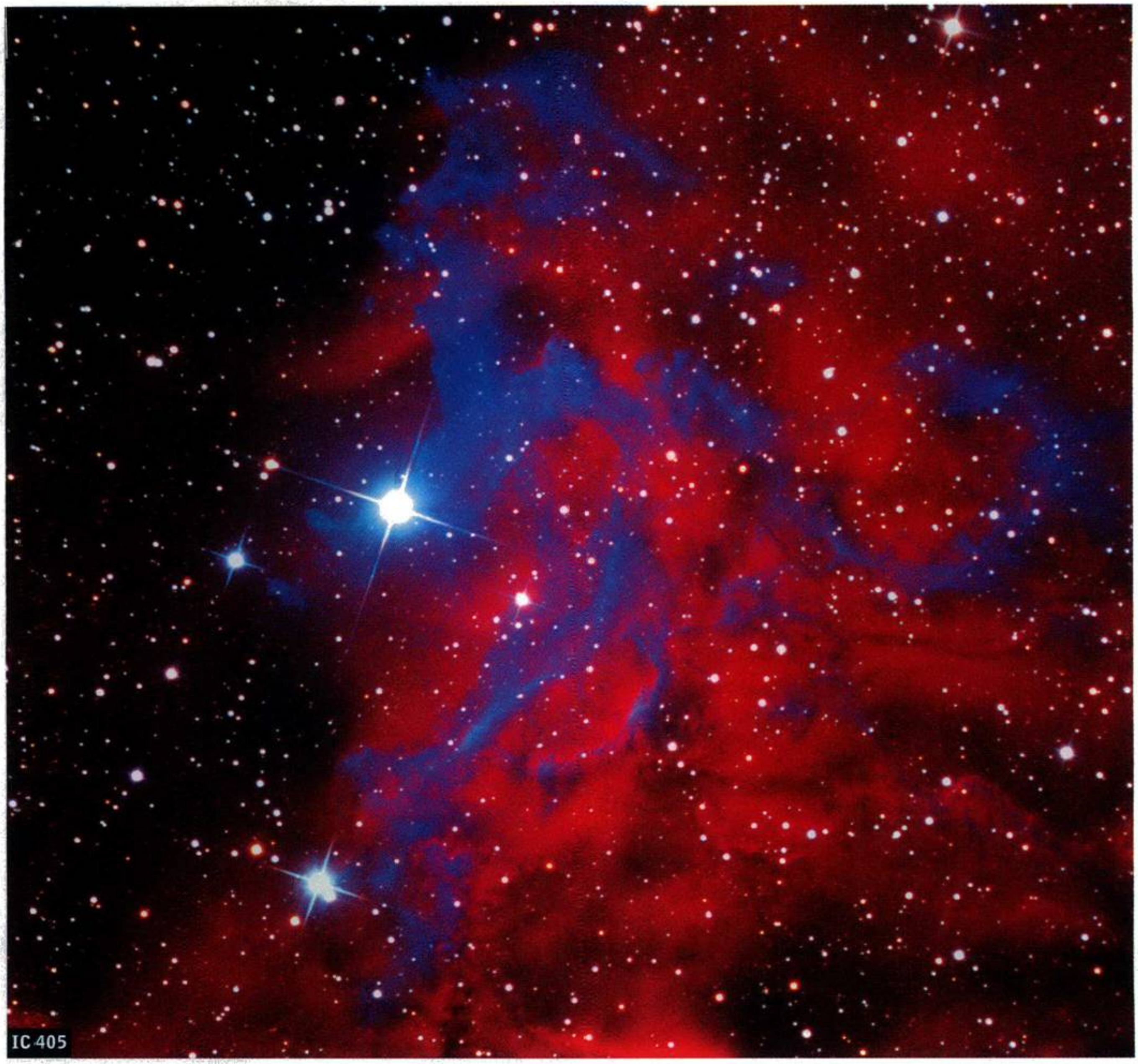
A pair of 7x50 binoculars reveals the pretty open cluster **NGC 1664**, located just 2° west of Epsilon (ε) Aurigae. Through a telescope at 100x, 40 stars between magnitudes 11 and 14 show up across a 5' diameter. Two prominent star chains arranged in opposing "V" shapes create a striking pattern that looks like a much smaller version of the wings in the constellation Cygnus the Swan. The cluster even sports a "neck" of six stars that extends southward before ending at an 8th-magnitude star. Despite a distance of 4,000 light-years and the richness of the surrounding field, NGC 1664 stands out nicely.

Tucked into the southwestern corner of Auriga lies the challenging globular cluster **Palomar 2**. It's one of only a handful of globulars — which form a huge halo surrounding the center of our galaxy — found in the direction opposite the Milky Way's center. At a distance of some 90,000 light-years, Palomar 2's brightest stars glow dimly at magnitude 18, and most backyard telescopes show nothing more than a comet-like haze. Even my 20-inch telescope at a dark desert site reveals only a dozen very faint stars in a circular halo 2' across. In smaller apertures, use high magnification and look for the graininess that indicates partial resolution.

Pan 2.5° southeast of Iota (ι) Aurigae to find the dark nebula **Barnard 29**, a cloud of obscuring material roughly 500 light-years away. It ranks among the most opaque nebulae in the sky, though that doesn't necessarily translate into easy visibility. In a 13-inch telescope, Barnard 29 appears as a gray, mottled region nearly devoid of stars that blends gradually into its starry surroundings. The darkest area appears 15' across. To the naked eye, the nebula forms part of a dark lane that runs from Iota Aurigae to Beta Tauri.

The star AE Aurigae currently lies in the central part of the constellation. Yet astronomers think this runaway star was ejected from the distant Orion Nebula nearly 3 million nears ago and has been covering roughly the distance between the Sun and Pluto every year since. AE Aurigae illuminates the **Flaming Star Nebula** (IC 405), an emission and reflection nebula. In a medium-aperture telescope, IC 405 appears as a faint fan radiating from AE Aurigae. Although photographs of IC 405 reveal a complex cloud more than 1° across, visual observers see an object only one-quarter that size. A hydrogen-β filter dramatically improves the view.

Artwork from *The Glorious Constellations*, © 1991; Harry N. Abrams, Inc.



IC 405

Tony and Daphne Hallas

A much more detailed emission nebula lies 1.5° east-southeast of IC 405. **IC 410** responds well to a nebula filter, showing richly detailed structures across a half-degree field even in small telescopes. The nebulosity glows brightest in a circular area some 5' in diameter that resides on the northwestern edge. A fainter strip some 20' long defines the western edge. The feature seems to follow the star chains visible in this rich telescopic field.

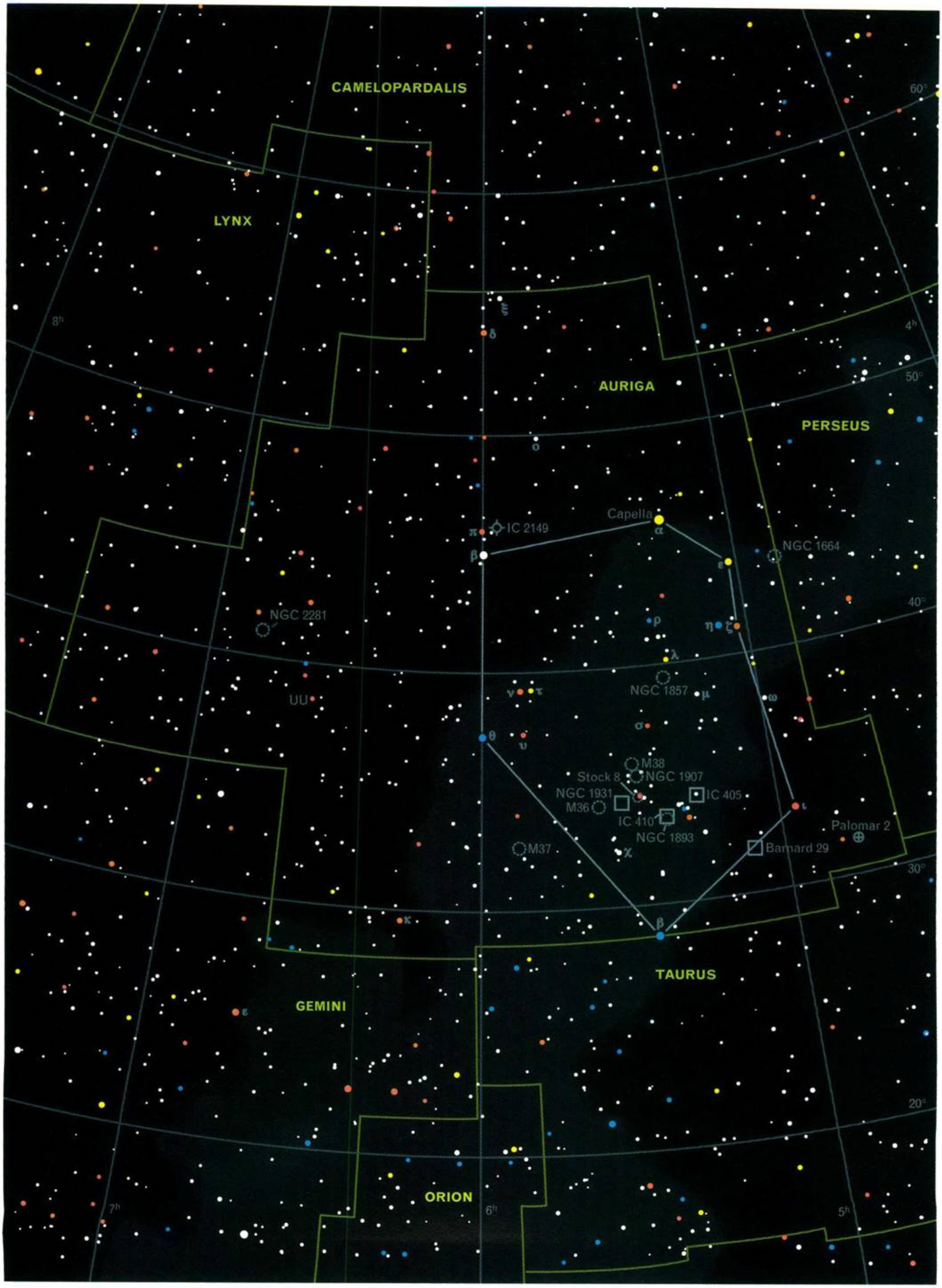
IC 410 envelops the open star cluster **NGC 1893**, whose hot, young members excite the gas in the surrounding emission nebula. A 10-inch scope at medium magnification reveals 60 stars between magnitudes 10 and 13 clumped tightly into an area 6' across.

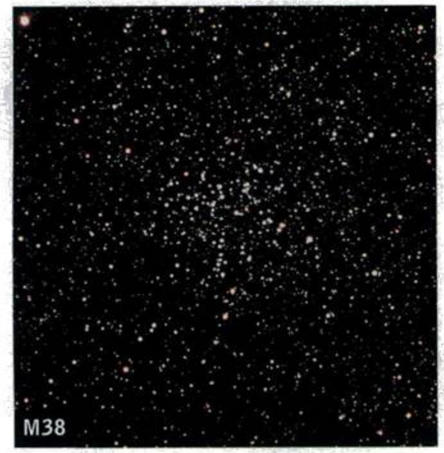
The open cluster **Stock 8** lies just 1.5° to the northeast. In an 8-inch telescope, 30 stars of magnitudes 11 to 13 fill an area 4' across. Despite lying in a rich field of Milky Way stars, Stock 8 appears well detached. The yellow, 5th-magnitude star Phi (ϕ) Aurigae shines just north of the cluster. A large scope reveals the extremely faint glow of the surrounding nebula, IC 417.

Now pan less than a degree to the east and you'll find the bright emission nebula **NGC 1931**, which surrounds a tiny open cluster that contains only five bright stars. An 8-inch scope at high magnification shows the nebula nicely. It appears 2' by 1' across with a northeast-southwest elongation and a brighter center. The nebula lies some 7,000 light-years away, and astronomers think it's farther away than the cluster because those stars don't appear to be reddened by it.

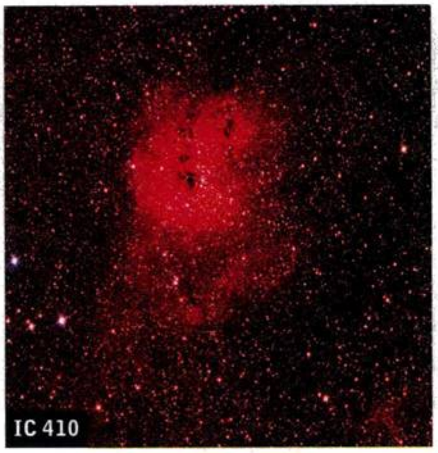
About 7° due south of Capella lies a pleasing group of 50 stars packed into a 5' diameter. The members of **NGC 1857** shine mostly at 13th and 14th magnitude and concentrate into a dense clump about 1' across on the southwestern edge. An 8th-magnitude yellow star at the center sets off the cluster.

All three Messier objects in Auriga are open clusters arranged in a line that runs down the spine of the Milky Way. The westernmost of these is **M38**, a spectacular cluster some 6,000 light-years from Earth that reveals more than 100 stars in an 8-inch scope. It appears about 20' across and contains enough stars brighter

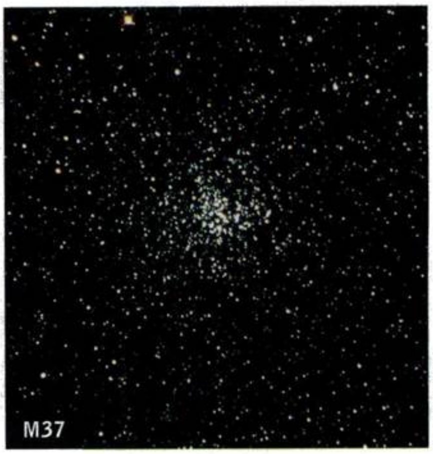

CAMELOPARDALIS
LYNX
AURIGA
PERSEUS
GEMINI
TAURUS
ORION
60°
50°
40°
30°
20°
8h
7h
6h
5h
4h
ξ
δ
ο
Capella
α
π
IC 2149
β
ε
NGC 1664
NGC 2281
ρ
η
ζ
λ
NGC 1857
μ
UU
ν
τ
ω
σ
θ
υ
M38
Stock 8
NGC 1907
NGC 1931
IC 405
M36
IC 410
NGC 1893
ι
Palomar 2
M37
χ
Barnard 29
β
κ
ε


M38

Michael Stecker


IC 410

Jason Ware


M37

Lee C. Coombs

than 12th magnitude that it stands out from the rich star background. Several chains of stars show up at higher magnifications, including one oriented north-south that sits just west of the center.

M38 joins with a companion cluster, **NGC 1907**, to form a rare pair similar to the famous Double Cluster in Perseus. Located just 0.5° south of M38, NGC 1907 shows 25 stars packed into a 4' diameter. Only 50 light-years separate these two clusters, and their comparable ages strengthen the argument that they are associated with each other.

Although it's the least spectacular of the Messier trio, **M36** remains a pleasing sight. An 8-inch telescope shows 50 stars in an area 10' across. Even 11x80 binoculars reveal more than a dozen members. Like almost all the open clusters in Messier's catalog, M36 can be seen with the naked eye from a dark site.

Arguably Auriga's best deep-sky object, **M37** marks the high note in the string of three Messier clusters. In a small telescope, 50 similarly bright stars shining from a distance of 4,200 light-years scatter uniformly across 10'. The brightest member — a pretty, 9th-magnitude star that glows with an orange hue — sits near the cluster's center. A 12-inch scope at a dark site brings out 150 stars that completely fill a medium-power field. Many observers have compared M37 to great clusters such as M11 in Scutum for its even stellar distribution and its definition from the surrounding starfields.

Sweep just a little more than 1° north-northwest of Beta Aurigae to pick up the planetary nebula **IC 2149**. Although it doesn't yield much detail, this bright, nearly stellar object makes a good target

Deep-Sky Objects in Auriga

Object	R. A. (2000.0)	Dec.	Mag.	Size/Sep.	Type	Notes
Palomar 2	4h46.1m	31°23'	13.0	1.9'	GC	
NGC 1664	4h51.1m	43°42'	7.6	18'	OC	
Barnard 29	5h06.2m	31°44'	—	10' by 10'	DN	
IC 405	5h16.2m	34°16'	—	30' by 20'	BN	Flaming Star Nebula
NGC 1857	5h20.2m	39°21'	7.0	5'	OC	
IC 410	5h22.6m	33°31'	—	40' by 30'	BN	
NGC 1893	5h22.7m	33°24'	7.5	12'	OC	
NGC 1907	5h28.0m	35°19'	8.2	6'	OC	
Stock 8	5h28.1m	34°26'	—	5'	OC	
M38 (NGC 1912)	5h28.7m	35°50'	6.4	21'	OC	
NGC 1931	5h31.4m	34°15'	—	4' by 4'	BN	Associated open cluster
M36 (NGC 1960)	5h36.1m	34°08'	6.0	12'	OC	
M37 (NGC 2099)	5h52.4m	32°33'	5.6	20'	OC	
IC 2149	5h56.3m	46°07'	10.7	8"	PN	
Theta Aurigae	5h59.7m	37°13'	2.6/7.1	3.6"	Dbl	
UU Aurigae	6h36.5m	38°27'	5.3	—	Star	Carbon star
NGC 2281	6h49.3m	41°04'	5.4	14'	OC	

Object: Designation in Messier, NGC, or other catalog. **R. A. (2000.0) and Dec.:** Right ascension and declination in epoch 2000.0 coordinates. **Mag.:** Visual magnitude. **Size/Sep.:** Size in arcminutes or arcseconds, separation in arcseconds.

The Charioteer

"For lo! I see afar,
O'er sailing the blue cragginess, a car
And steeds with streamy manes — the charioteer
Looks out upon the winds with glorious fear."
Sleep and Poetry, *John Keats (1795–1821)*

Auriga stands among the earliest identified constellations, documented as far back as the Babylonians. And all cultures have regarded Auriga as a charioteer. Yet no depiction of the constellation shows a chariot or horses. Instead, the driver holds his steeds' reins in his right hand.

In Greek mythology, Auriga represents Erichthonius, a legendary king of Athens. He was the son of Hephaestus, the god of fire and craftsmanship, better known by his Roman name Vulcan. But he was raised by the goddess Athene, for whom the city of Athens is named. She taught Erichthonius how to tame horses, and he became the first to harness four horses to a chariot. For this achievement, he was awarded permanent residence among the stars.

As if driving a chariot wouldn't command all his strength and concentration, Auriga also manages to carry a goat on his shoulder. The bright beacon Capella symbolizes this goat. And her young ones, nicknamed "The Kids" and represented by the small, elongated triangle of 3rd- and 4th-magnitude stars consisting of Epsilon (ε), Eta (η), and Zeta (ζ) Aurigae, lies just a few degrees to the southwest.

In the zodiac that formed the ceiling of the temple at Dendera, Egypt, Capella is represented by a mummified cat held in the hands of a man wearing a feather crown. The star held a special place in the worship of the Egyptian god Ptah. Many temples dedicated to Ptah, including the one at Karnak, were oriented toward Capella. — *Richard Talcott*

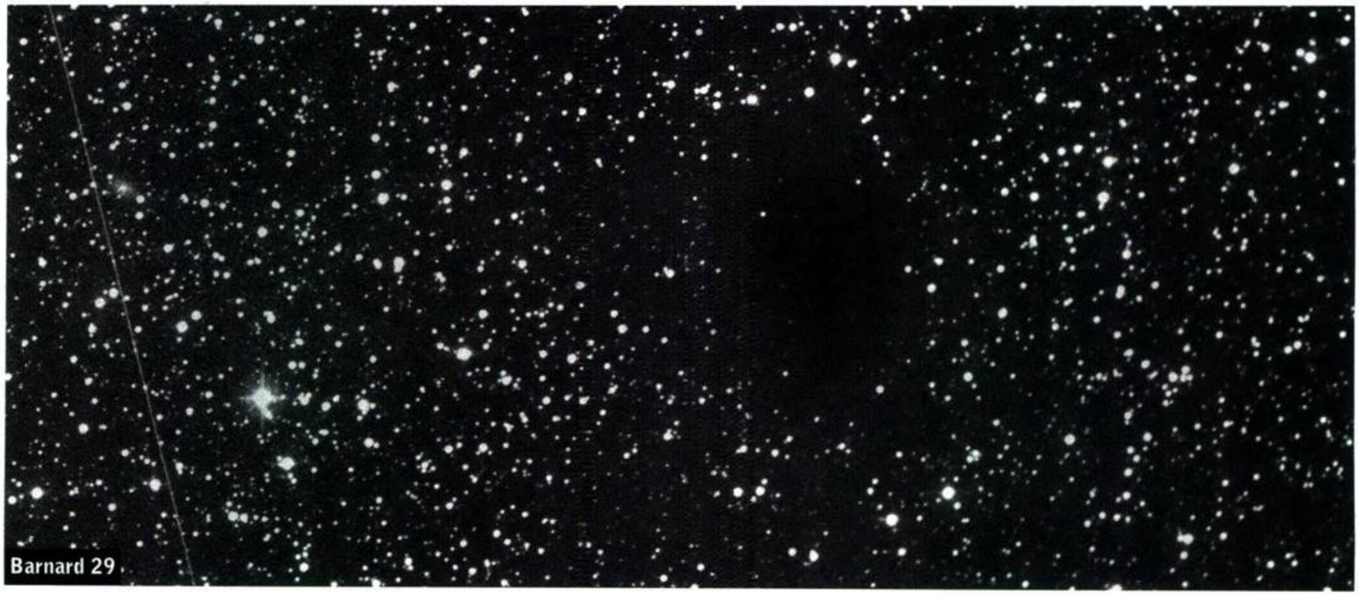
for suburban observers. Using a nebula filter, "blink" the field by passing the filter between the eyepiece and your eye. On a night of good seeing at magnifications above 200x, IC 2149 shows a small, bluish disk elongated east-west with a conspicuous 12th-magnitude central star.

On a night when the air settles down, point your telescope at the double star **Theta Aurigae**. Although a generous 3.6" separates the pair, a difference of more than four magnitudes makes this a difficult split. (Clean optics will certainly help.) The dim companion lies northwest of the primary.

Next sweep your telescope about 7° east from Theta and prepare to be wowed. The carbon star **UU Aurigae** has an impressive reddish tint visible with direct vision in any telescope. This cool star spans 370 solar diameters and lies 950 light-years away.

We close our tour in eastern Auriga with the open cluster **NGC 2281**. This scattered group of 25 stars covers an area some 10' across. A diamond-shaped asterism of 8th-magnitude stars marks the center of the cluster.

Tom Polakis is an aerospace engineer from Tempe, Arizona. He particularly enjoys deep-sky observing and astrophotography.



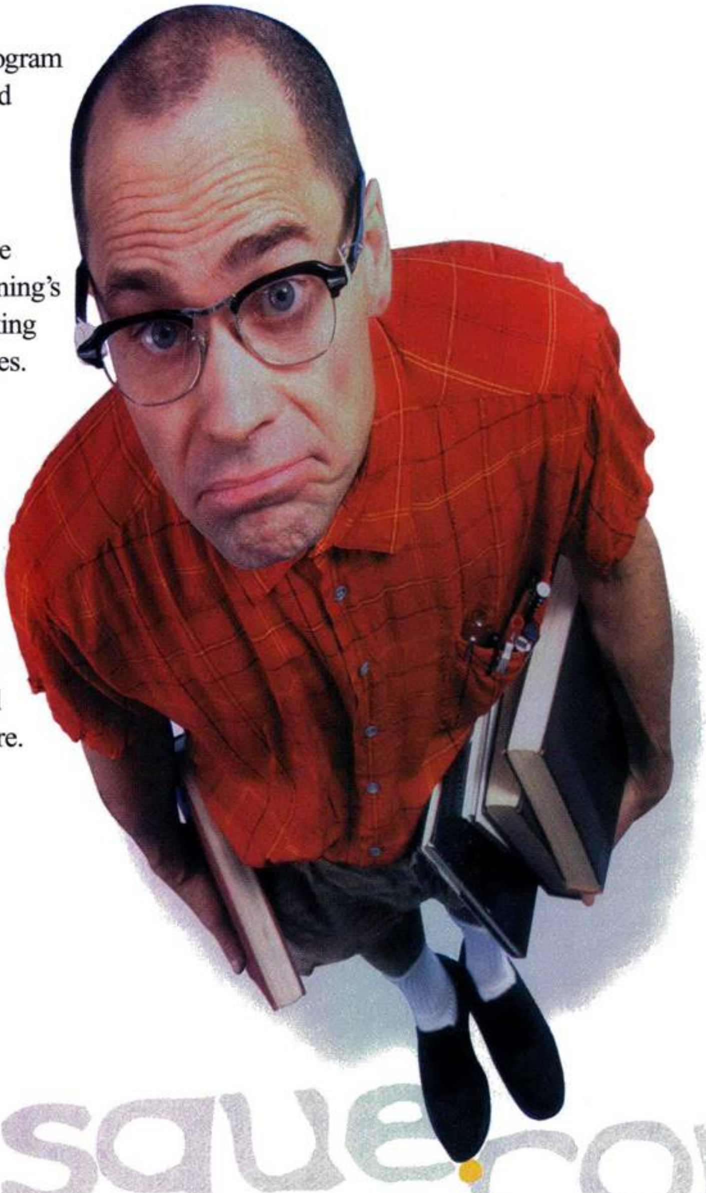
Barnard 29

Martin C. Germano

So, you named your daughter NGC4565. Who says you're obsessed?

Certainly not us.

We understand what drives the journey from casual stargazer to serious astronomer. It's the passion that can keep you awake for three straight days and nights — and we share it.



Seventeen years ago, we released TheSky,™ a program with all of 1,000 stars. It quickly became the gold standard in astronomical software.

We were hooked.

Today, our software allows you to reference more than a half billion celestial bodies, script an evening's viewing, correct for telescope pointing and tracking errors, control digital captures and process images. It even allows you, via the Internet, to operate observatories on the other side of the globe.

We couldn't stop.

In our spare time, we've created the Paramount GT-1100,™ a robotic telescope mount system so advanced it's blurred the line between professional and amateur astronomy. We've even put TheSky on a hand-held so you'll be able to identify the heavens anytime, anywhere.

Obsession? Who says *you're* obsessed?

THESKY

Astronomy Software
1.800.843.7599

bisque.com

Take your best shot!

WWW.BISQUE.COM SOFTWARE BISQUE, 912 TWELFTH STREET, GOLDEN, COLORADO 80401 U.S.A. THESKY AND PARAMOUNT GT-1100 ARE TRADEMARKS OF SOFTWARE BISQUE

An Eye for Luxury

Putting the test to the new 12.5-inch Ritchey-Chrétien telescope from RC Optical Systems.

by Gregory Terrance

With their characteristic wide, high-quality, and aberration-free field of view, Ritchey-Chrétien telescopes are renowned among seasoned observers as the Ferrari of optical systems. Touted as the perfect telescope for medium- to large-format CCD work and film photography, these beauties command a handsome price tag — generally more than $10,000. Colorado-based RC Optical Systems makes the R-C its staple. Founded in 1998, RC Optical Systems offers a wide range of R-C mounts and optical tube assemblies (OTAs), including a 10-inch f/9, 12.5-inch f/9, 16-inch f/8.4, 20-inch f/8, and the recently introduced 25-inch f/7.5 and 32-inch f/7. Earlier this year, I tested the new 12.5-inch f/9 OTA.

First Things First

My first impressions of the 12.5-inch R-C scope were promising. Within a few hours of its arrival — in three separate boxes — I unpacked and assembled the complete telescope. (With new design improvements, RC Optical Systems can now safely ship the 10-inch and 12.5-inch telescopes pre-assembled and pre-collimated [optically aligned] in a robust, airline-safe carrying case. This makes them virtually ready to use straight out of the box.) The 12.5-inch I tested came with a fringe analysis and interferometer data sheet for the optical set; further documentation such as the owner's manual is sent by e-mail before shipment.

Considering its large aperture, the 12.5-inch's carbon-fiber OTA is a light and manageable 40 pounds. On top of that, it's only 37 inches long, which means that many astronomers will be able to heft it onto a telescope mounting without help.

Setting Up

Initially, the scope provided some nice lunar views with low to moderate magnifications. After observing the Moon, I followed the steps outlined in the owner's manual to perform the fine collimation, which requires the user to adjust the telescope's optical set based on the appearance of a defocused star at high power. Even with experience on a Newtonian reflector, it took me some time to interpret the subtleties of this process. An inexperienced user should set aside a few clear nights to get everything aligned.

The fine adjustments were well worth the effort, as the telescopic images became noticeably crisper and sharper. Prior to fine collimation, the lunar crater Plato appeared to have a flat and featureless floor, devoid of detail. Afterwards, however, four of the delicate craterlets that lay on the crater's dark floor snapped into view during good seeing moments.

The ability to view such small craters indicated that collimation was nearly ideal but also that the R-C's optics are high quality. The zero expansion Astro-Sitall optics are coated with enhanced aluminum, resulting in 96.9-percent reflectivity.

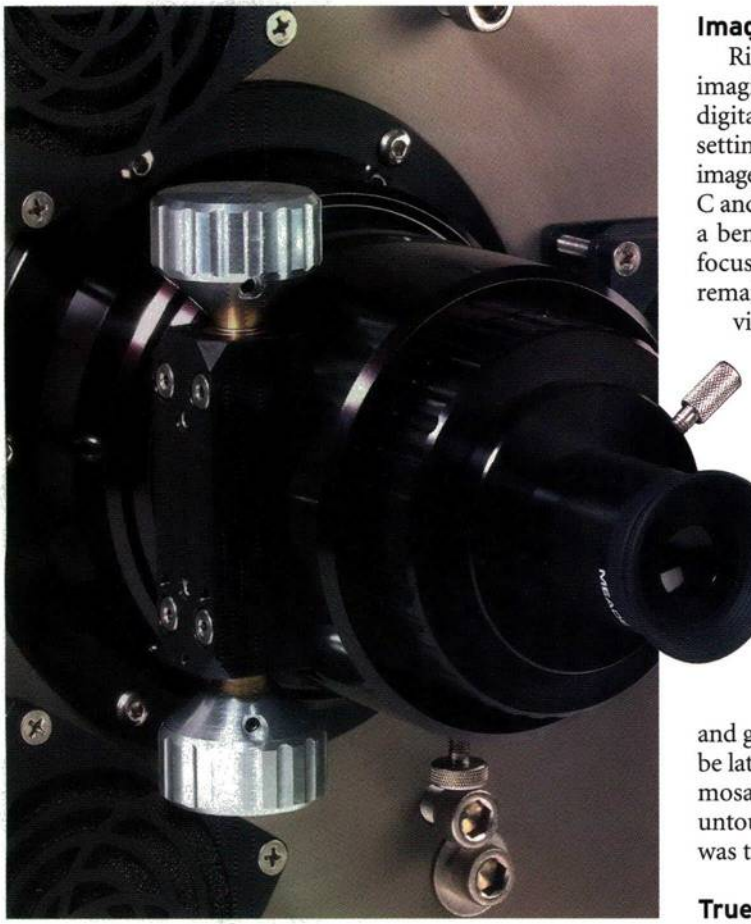
Above, right: The 12.5-inch Ritchey-Chrétien scope by RC Optical Systems makes observing and photography a snap for experienced users.

Below: A heater can be applied to the secondary mirror to prevent dew accumulation.

All equipment photos/*Astronomy:* William Zuback

This beautiful lunar mosaic proves the imaging capabilities of the 12.5-inch Ritchey-Chrétien scope by RC Optical Systems when coupled with a CCD camera. The photo, a composite of four images, was captured with a Finger Lakes IMG1300L CCD camera.

Gregory Terrance



▲The scope's setup allows a focuser to be mounted to the rear plate.

RC Optical Systems
3507 Kiltie Loop
Flagstaff, AZ 86001
Phone: (928) 773-7584
Website: www.rcopticalsystems.com

Scope Specs:
System: 12.5-inch f/9
Base Weight: 37 pounds
Length: 36.5"
Diameter: 15.3"
Primary Focal Length: 40"
Amplification of Secondary: 2.85x
Secondary Size: 4.85"
Primary to Secondary Spacing: 26.50"
Primary Hole: 3.5"
Base Price: $13,450
Availability: This month

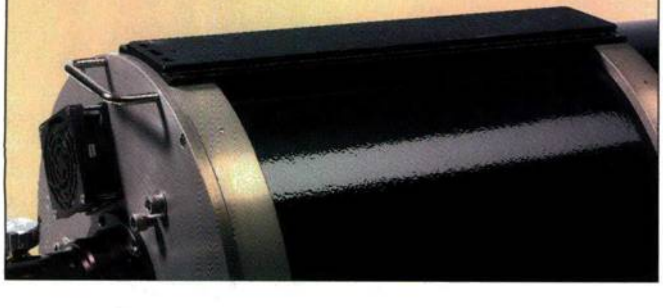


Image is Everything

Ritchey-Chrétien telescopes are often touted for impeccable imaging abilities. I tested the 12.5-inch with a large-format digital camera. After focusing the telescope and locking the settings, I began a series of exposures. Surprisingly, the first image was enough to clearly reveal the difference between the R-C and a high quality f/5 Newtonian reflector that I was using as a benchmark. The R-C's star images were round and tightly focused as expected. The difference, however, was that they remained so without variation, across the entire CCD field of view. This effect, which is called a "flat field," is the hallmark of George Ritchey's optical design (see "Ritchey's Legacy," page 83).

Nearly all reflecting telescopes exhibit coma, an aberration that creates elongated star images that become worse toward the outer edge of the field. Large CCDs and 35mm film readily show this effect since they capture a wide swath of the light emerging from the telescope. True to Ritchey's original design, however, the 12.5-inch R-C and its hyperbolic primary and secondary mirror provided images that appeared to be free from coma. Nearly two weeks later, I shot images of the Moon using the same setup.

Waking early, I rushed to the observatory before sunrise and grabbed a series of overlapping lunar images, which would be later manipulated with my computer to create a single lunar mosaic. The focus settings from the previous week were left untouched as each exposure was taken. Amazingly, each image was tack sharp (see "Lunar Mosaic" image, page 81).

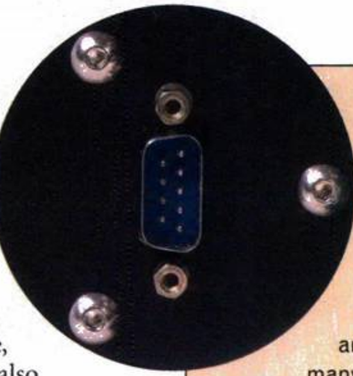
True "Focus and Forget" Technology

RC Optical Systems' telescopes are designed to maintain pinpoint focus from night to night — in fact, over weeks and even months — thus eliminating one of the most demanding aspects of astroimaging: the need to refocus. The usual suspects for changes in a telescope's focus are the expansion or contraction of the optics and the materials within the tube assembly. RC Optical Systems owner Brad Ehrhorn actually started the company in part because he was frustrated by the need to refocus many times during the course of an evening.

Most telescopes use optical material and tubes (aluminum or fiberglass) that have a high coefficient of expansion, making them thermally unstable. As the ambient temperature around the telescope changes, so does the focus (from night to night or within a single night). These effects are common to reflectors and refractors and are much more pronounced with Cassegrain telescopes (due to the amplification ratio of the secondary mirrors). To fight these focusing gremlins, RC Optical Systems uses pure carbon-fiber tubing and low expansion optics that remain thermally stable over long periods of time. RC Optical Systems' "Focus and Forget" is more than just a slogan.

Tube Components, Bells, and Whistles

The tube's internal and external components are made of high-grade "6061" aluminum, and computer-machined for precision and consistency. For strength and rigidity the lightweight carbon-fiber tube is supported by a series of tube rings. A single ring is located at the telescope's front aperture, where it will accept an optional lightweight dew shield. The next ring lies within the tube and is used to support the four-vane spider and secondary mirror assembly. Finally, there is a pair of machined external rings for both mounting the telescope and attaching auxiliary equipment. These rings are drilled to accept



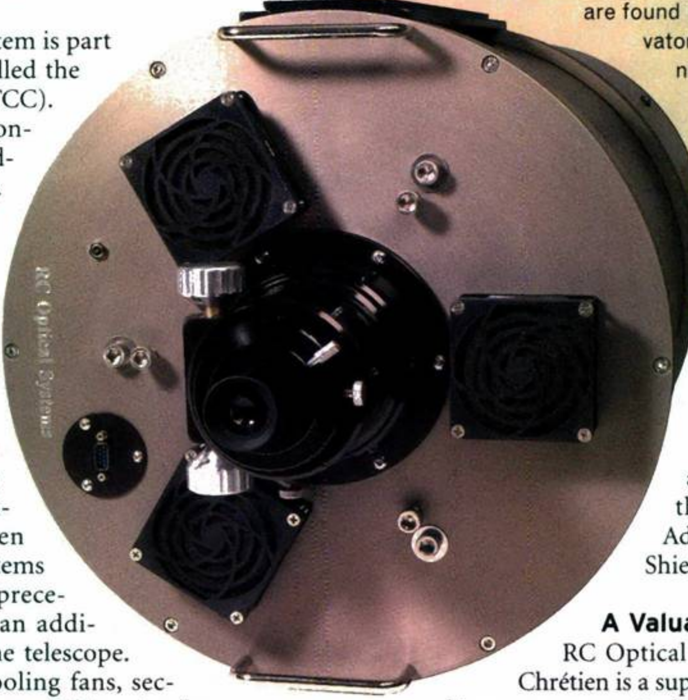
▶ The Telescope Command Center software can be attached to the rear mounting plate.

high-quality, expert-machined Losmandy mounting plates.

Most of the telescope's weight lies at its "working end" where the 7/16" thick rear-mounting plate is located. The plate provides a rigid support for the telescope's primary mirror, internal collimating plates, and two-stage, knife-edged baffle system (for the primary). It also features a passive cooling system (three machined cooling vents), which can be augmented with cooling fans. The primary mirror is collimated via three push-pull bolt sets. The secondary mirror is baffled with a similar nesting of adjustable bolts, which allows for fine collimation.

Although a focuser may be mounted onto the rear plate, the R-C's standard focusing mechanism is located at the secondary mirror. The secondary focuser features twin stainless steel linear races riding on four linear ball bearings that never gave a hint of image shift during my visual and imaging tests. I also tested RC Optical Systems' electronic secondary focuser, which is particularly useful for someone with an imaging room away from the main observatory. The system is a servomotor (attached to the secondary focuser) controlled by a hand-held control unit with a large focusing dial. This dial supplants the telescope's focuser, and when used in the fine setting is precise enough to move the secondary mirror in 0.0025" increments.

The secondary focusing system is part of a more elaborate option called the Telescope Command Center (TCC). The TCC consists of a hand control unit, an assortment of hardware attachments, and a software counterpart that allows a user to manage nearly every aspect of telescopic operation. With this option in place the user has the ability to control the secondary mirror position (allowing for software-controlled autofocusing), secondary dew heater temperatures, cooling fan speeds, and even the orientation of a CCD camera when used with the RC Optical Systems Instrument Rotator. This unprecedented level of control adds an additional $1,200 to the cost of the telescope. But this price includes the cooling fans, secondary dew heater and the servo DC motor for the secondary focuser.



◀ The rear mounting plate provides sturdy support for the scope's primary mirror.

Another option available for the die-hard astroimager is a series of spacers called the "Fixed Instruments" Rear Cell Adapter Set. With this set you can bolt the CCD camera directly to the telescope's rear plate and have the correct tube-to-CCD distance. The Fixed Instruments adapter eliminates focuser drift and flexure during exposures. For the hobbyist observing in dew-prone areas, a 10-inch carbon dew/light shield (with mounting ring) is available. The dew shield is light enough so most mounting systems will not require re-balancing with its addition to or removal from the telescope. The Rear Cell Adapter Set is $500 and the Dew Shield system is $400.

A Valuable Find

RC Optical Systems' 12.5-inch Ritchey-Chrétien is a superb imaging machine. It combines a proven optical design with exceptional optics and low expansion components. The wide-field, coma-free system is capable of yielding astonishing images for a scope of such aperture. The "Focus and Forget" technology simplifies the imaging process by eliminating the need to refocus between shots. This is one scope that won't disappoint. ■

Gregory Terrance observes from his home-built observatory in Lima, New York. He has been involved with CCD astronomy for over a decade, and has written more than a dozen articles for Astronomy.

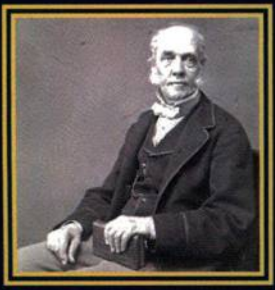
Ritchey's Legacy

George Willis Ritchey was an American optician and a colleague of the famous astronomical entrepreneur George Ellery Hale. Hale recognized Ritchey's abilities and his attention to detail. The two embarked on a successful and profitable working relationship spanning many years. When Ritchey was working at Mount Wilson Observatory, he introduced a new optical design that was made in cooperation with the French optical designer Henri Chrétien. This design produced superior telescopic images over a large photographic field and virtually eliminated the optical aberration known as coma. Even today, the Ritchey-Chrétien has the largest aberration-free field of view of any reflecting telescope.

Unfortunately, Hale refused to consider this new design for Mount Wilson's 100-inch mirror. As the grinding of the mirror reached completion, Hale fired Ritchey over their differences and used his influence to banish Ritchey from American astronomy. Years later, Ritchey landed a commission with the U.S. Naval Observatory in Washington, D.C. to build a telescope of his design. Although he died before the telescope was completed, it became a success. History has been kinder to Ritchey than his contemporaries. Today Ritchey-Chrétien telescopes are found in most professional observatories across the globe. In fact, nearly every large telescope built since Hale's 200-inch has used the Ritchey-Chrétien design. The most famous of these is none other than the Hubble Space Telescope. — *G. T.*

Big Telescopes & Sharp Eyes

by Richard Jakiel



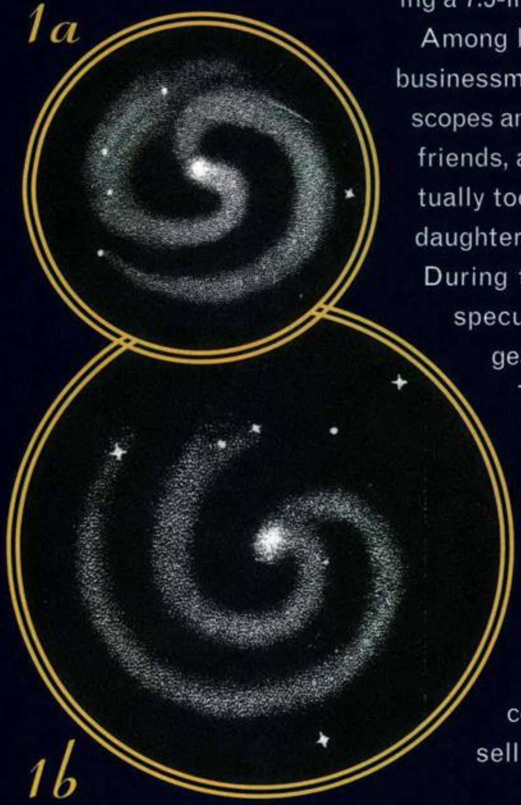
Among wealthy Victorian amateur astronomers, William Lassell stood out as an observer and telescope maker. Mary Lea Shane Archives of the Lick Observatory, Univ. of California–Santa Cruz

William Lassell was one of the greatest visual astronomers of the 19th century. Today, the only astronomers who look through eyepieces are the backyard kind, but in Lassell's day that was the pathway to discovery. Applying his sharp eye and using a large telescope of his own manufacture, Lassell discovered Triton, the largest moon of Neptune, shortly after the planet itself was discovered. He was also first to see the uranian moons Ariel and Umbriel, and he was the co-discoverer of Saturn's moon Hyperion. For all that, his biggest contribution to astronomy was demonstrating the need to place big telescopes under clear, dark skies. And in that, his legacy lives on today.

William Lassell was born on June 18, 1799 in Bolton, England. His family moved to Liverpool in 1815. In 1824, after two years of apprenticeship, he started a brewery that was soon thriving. Even before then, however, he had begun an interest in astronomy, building a 7.5-inch Gregorian reflector when he was 22.

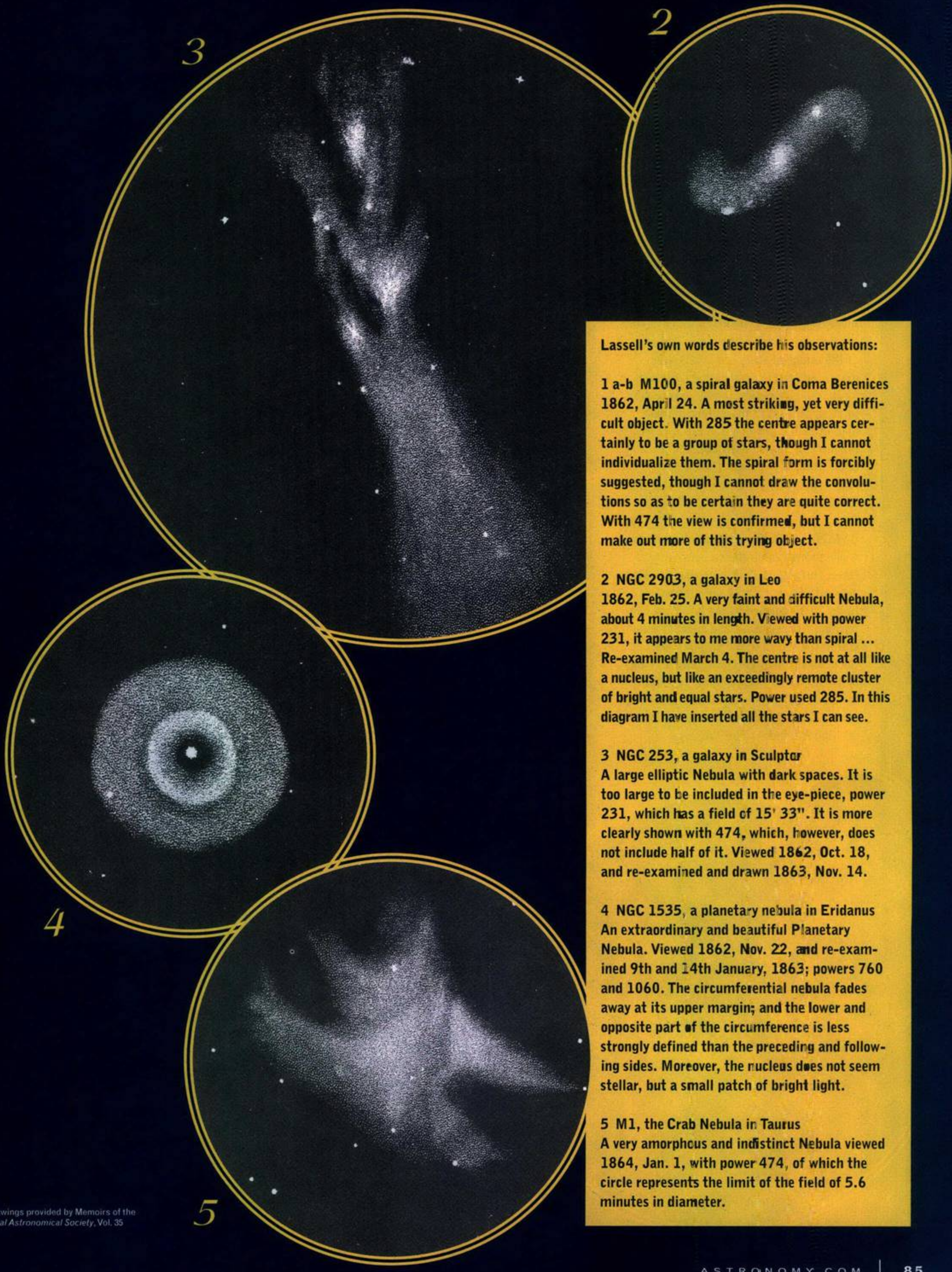
Among his close friends were the brothers Joseph and Alfred King, fellow Liverpool businessmen and amateur astronomers. The three spent nights testing each other's telescopes and observing planets and stars. In 1827 Lassell married Maria King, a sister of his friends, and in time the couple had a son and four daughters. The son, William II, eventually took over the brewery, freeing his father to pursue astronomy. Two of Lassell's daughters, Caroline and Jane, often assisted at the telescope.

During the 1830s, Lassell constructed a 9-inch f/12.4 Newtonian reflector with a speculum metal mirror. He placed it on a cast-iron fork mount with precision gearing that allowed high-power observations of planets and deep-sky objects. The design was so novel that a detailed description of the instrument and observatory was published in the *Memoirs of the Royal Astronomical Society* for 1842.



Starfield Observatory

To house the 9-inch, Lassell built a new observatory which he christened Starfield. His observations of planets with the 9-inch gained him international recognition. But to compete on equal terms with other observers, Lassell planned a much larger telescope. In 1844,



Drawings provided by Memoirs of the *Royal Astronomical Society*, Vol. 35

Lassell's own words describe his observations:

1 a-b M100, a spiral galaxy in Coma Berenices
1862, April 24. A most striking, yet very difficult object. With 285 the centre appears certainly to be a group of stars, though I cannot individualize them. The spiral form is forcibly suggested, though I cannot draw the convolutions so as to be certain they are quite correct. With 474 the view is confirmed, but I cannot make out more of this trying object.

2 NGC 2903, a galaxy in Leo
1862, Feb. 25. A very faint and difficult Nebula, about 4 minutes in length. Viewed with power 231, it appears to me more wavy than spiral ... Re-examined March 4. The centre is not at all like a nucleus, but like an exceedingly remote cluster of bright and equal stars. Power used 285. In this diagram I have inserted all the stars I can see.

3 NGC 253, a galaxy in Sculptor
A large elliptic Nebula with dark spaces. It is too large to be included in the eye-piece, power 231, which has a field of 15' 33". It is more clearly shown with 474, which, however, does not include half of it. Viewed 1862, Oct. 18, and re-examined and drawn 1863, Nov. 14.

4 NGC 1535, a planetary nebula in Eridanus
An extraordinary and beautiful Planetary Nebula. Viewed 1862, Nov. 22, and re-examined 9th and 14th January, 1863; powers 760 and 1060. The circumferential nebula fades away at its upper margin; and the lower and opposite part of the circumference is less strongly defined than the preceding and following sides. Moreover, the nucleus does not seem stellar, but a small patch of bright light.

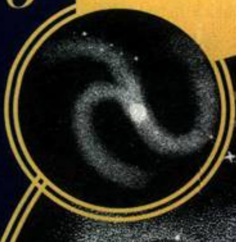
5 M1, the Crab Nebula in Taurus
A very amorphous and indistinct Nebula viewed 1864, Jan. 1, with power 474, of which the circle represents the limit of the field of 5.6 minutes in diameter.

6 M83, a spiral galaxy in Hydra
A faint Nebula with bright nucleus, observed 1862, May 20. A singular object, the nucleus obviously stellar. One star is certainly outside the nucleus, north preceding. Re-examined 22nd May. The nucleus seems quite disconnected from the nebula, conveying the idea of a small bright compressed cluster; whilst the nebula is very faint. There are several minute stars south-preceding, where I have marked some; but they are not so constantly visible as to enable me to assign precisely their number or places.

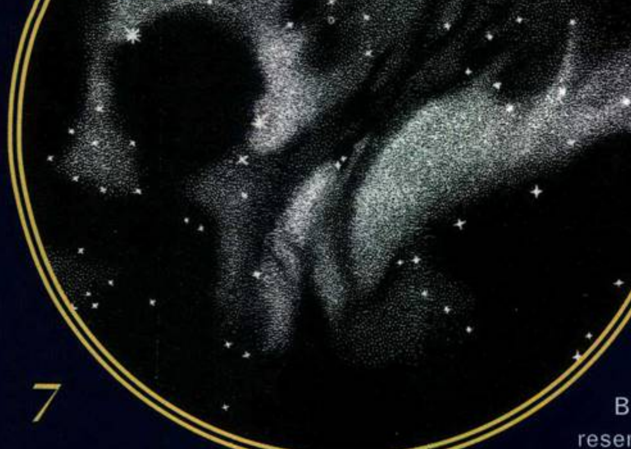
7 M17, the Omega Nebula in Sagittarius
A very remarkable Nebula in which there is much detail and many stars. Eleven of the principal stars (74 in all) were measured, and the remainder laid down by careful estimation, while some approximation at least of their proportionate magnitudes is preserved in the drawing. Magnifying powers used 285 and 228. Scale 166".4 = 1 inch. The circle represents the field of the 228 eye-piece, 13'.7 in diameter.

8 M20, the Trifid Nebula in Sagittarius
A most remarkable object, consisting of several bright nebulous patches, sprinkled over with many stars of various magnitudes, distinguished by the brightest two forming a conspicuous and unequal double star in the centre of the brightest part of the nebula. Surveyed 1862, June 27, and on this and many other nights re-examined, several of the stars measured and the nebula carefully drawn. The scale of the drawing is 1 inch = 166".4.

6



7



he visited William Parsons, the Earl of Rosse, at Birr Castle, Ireland. He inspected the great 72-inch reflector and workshops there, coming away with new ideas. With the help of James Nasmyth, a gifted engineer and amateur astronomer, Lassell designed and built an equatorially mounted 24-inch Newtonian reflector. To grind and polish the nearly 400-pound metal mirror, Nasmyth helped Lassell build an elaborate precision polishing machine.

The 24-inch was a larger version of the 9-inch, and its mirror was made of speculum metal, an alloy of copper and tin that took a bright polish. The mirror was ground to such high accuracy that the images rivaled the largest refractors of the time, a major breakthrough in reflector optics. The new telescope was complete by late 1845 and housed in a 30-foot dome. Lassell was soon using it for a series of key discoveries.

On September 23, 1846, the planet Neptune was discovered at Berlin. Perhaps the most electrifying astronomical discovery of the century, the news spread quickly to England, where Lassell viewed the distant planet on October 2 and 3, 1846. The 24-inch easily resolved the planet's disk. On October 10, Lassell found the dim "star" close to the planet. It was Triton, Neptune's largest satellite.

Battle Over Saturn

Besides observing the far outer planets, Lassell also viewed a favorite, Saturn, where he made several important discoveries. But this time, he faced stiff competition from William Cranch Bond, the director of the Harvard College Observatory in Cambridge, Massachusetts. Bond had at his disposal a superb 15-inch refractor, one of the finest instruments of the period. The intense rivalry between Lassell and Bond resulted in a series of nearly simultaneous discoveries.

The first was the discovery of the eighth satellite of Saturn. On September 16, 1848, Bond spotted "a point of light, resembling a star of the 17th magnitude . . . in the plane of Saturn's ring." An ocean away, Lassell independently found the tiny moon on September 18. Both men were credited with the discovery, although it was Lassell who got the honor of naming the object Hyperion.

Just two years later, the faint, dusky, innermost C ring of Saturn was discovered. Bond was the first once again, recording a dusky ring on November 15, 1850. Only a few days later, Britain's William Dawes detected the elusive ring using only a 6.3-inch refractor. On December 3, 1850, Lassell confirmed the existence of the ring using Dawes' scope. Observing the planet at 298x, Lassell was "struck with a remarkable phenomenon" which he described as: "It appeared as if something like a crape veil covered a part of the sky within the inner ring ..." The term crape (or crepe) ring gained quick acceptance and is still used today, providing a nice consolation prize for Lassell.

His reputation as an observer was gaining him international fame. In 1851, Queen Victoria made a special trip to see the famous amateur. As the story has it, she rose and advanced to meet him when he entered the room. Custom decreed that royalty always sat while everyone else stood. Such an action showed Lassell great honor and respect.

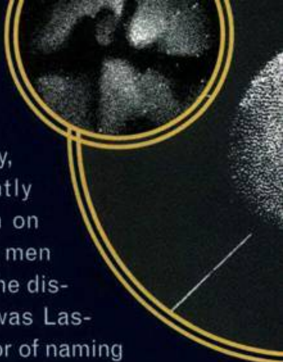
Quest For Better Skies

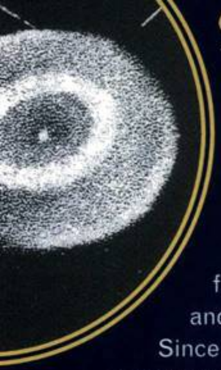
But Starfield skies were far from ideal, thanks to the high latitude and frequent overcast skies. In search of something better, Lassell decided to relocate the 24-inch to Valletta, Malta. This was the first time an astronomer had relocated a telescope for clearer skies. It was a key step, both for Lassell and astronomy's future.

The tiny island of Malta lies in the central Mediterranean at 36° north, almost 17.5° more southerly than Liverpool. Its conditions and climate were perfect — long runs of clear skies coupled with rock-solid seeing.

Lassell wasted no time in Malta before his next major discovery of two new satellites around Uranus, Ariel and Umbriel. Saturn, always a favorite

8




9

target, received considerable scrutiny too. On November 1, 1852, he saw the globe of Saturn through the Cassini Division, a great feat for visual astronomy and a testament to his skill. Since then, this has been duplicated less than a dozen times.

The Orion Nebula (M42) was another favorite. Malta's lower latitude allowed much more detailed study of it than the skies of England did. Lassell published a paper in 1854 which contains detailed observations of this and other objects:

Regarding M42, he wrote: "A marvelous spectacle. The brilliancy of the trapezium and of the 5th and 6th stars was most striking ... The whole aspect is that of a number of masses of fleecy cloud, thin at the edges, and packed one behind another; appearing to be a deep stratum of successive layers of nebulous substance."

M1, the Crab Nebula: "Long filaments run out on all sides, and there seems to be a number of very minute and faint stars scattered over it ..."

And M46 and NGC 2438: "A glorious cluster, with a planetary nebula within it . . . Its form [NGC 2438's] is circular, with a star or stellar nucleus, nearly, but not quite in the centre ..."

A New Telescope

The success of the 24-inch at Malta soon had Lassell contemplating a much larger instrument. Plans were quickly drawn up and by 1859, a 48-inch f/9.4 Newtonian stood at Starfield. The huge tube was 37 feet long, made of flat iron bars. It was mounted in a fork mount similar to the smaller scopes. The 48-inch carried a massive speculum mirror weighing more than a ton. Though not clock-driven, it was geared so that an assistant turning a crank caused the 8-ton scope to track the stars smoothly. A large mobile observer's platform gave access to the eyepiece high in the air.

The 48-inch didn't stay long in Britain. In 1861 it was shipped to Malta where it remained until 1865. Lassell and his assistant Albert Marth surveyed many galaxies, planetary nebulae, and other deep-sky objects. They also observed the outer planets and made measurements of the then newly found companion star to Sirius. They compiled a catalog of 600 newly discovered nebulae — most of these observed by Marth.

The telescope revealed spiral structure in many "nebulae" now known to be galaxies; the most notable include M77, M99, NGC 5247, M83, and M51. Planetary nebulae were another favorite target, and Lassell made beautiful detailed drawings of NGC 1535, NGC 2392 (the Eskimo), NGC 3242 (Ghost of Jupiter), and M27 (the Dumbbell). Perhaps one of the most spectacular drawings Lassell executed was of M17, the Omega Nebula. Even today, it remains one of the most faithful renderings ever made.

Sunset Years

Back in England, Lassell continued observations with the 24-inch. But to escape Liverpool's polluted skies, he moved to Maidenhead in Berkshire, where he re-erected the 24-inch in a new observatory. He used it until 1878, continuing to observe the outer planets, especially Saturn.

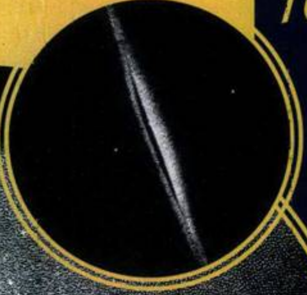
In 1865, the great 48-inch telescope was shipped back to England, never to be used again. Lassell offered to give the telescope to a new observatory in Melbourne, Australia. However he was turned down by the local committee who decided to build their own telescope, a rejection that hurt. In 1880, the 48-inch was broken up for scrap and destroyed.

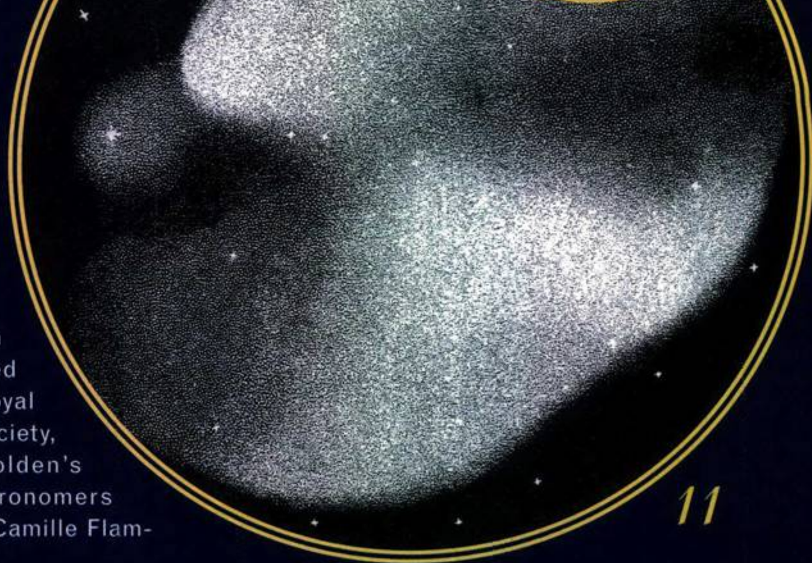
His final years were not entirely tranquil. In 1874, Edward Holden challenged Lassell's discovery of Ariel and Umbriel, claiming they had been seen by William Herschel in the 1780s. Lassell was furious. In a strongly worded protest to the Royal Astronomical Society, he refuted Holden's allegation. Astronomers Asaph Hall and Camille Flam-

9 M27, the Dumbbell Nebula in Vulpecula
The "Dumb-Bell" Nebula. The annexed drawing is the most faithful picture I have been able to produce as the result of a great number of observations with a great variety of magnifying powers, and under the best circumstances which offered.

10 NGC 4565, an edge-on galaxy in Coma Berenices
1862, April 29. A very remarkable Nebula. Examined with great care, and for a long time, with powers 474 and 1060. I can see no convolutions. I consider the drawing good. There are three minute stars in the nebula. The circle represents the field of the 474 eye-piece.

11 NGC 7009, the Saturn Nebula in Aquarius
1862, August 23. My first impression of the Nebula was that it was a sky-blue likeness of Saturn. Viewed with higher powers, the brilliancy and peculiarity of the colour are less striking, but the conformation of this truly wonderful object attracts the attention even more strongly. Under the most favourable circumstances, and after patient attention with lower powers, I thought that I employed even 1480 with advantage. The annexed drawing gives the best impression I could obtain under various circumstances and magnifying powers. The transverse axis of the ellipse is inclined the parallel about 13° and the length and breadth of the ellipse are respectively about 26" and 16½".


10


11

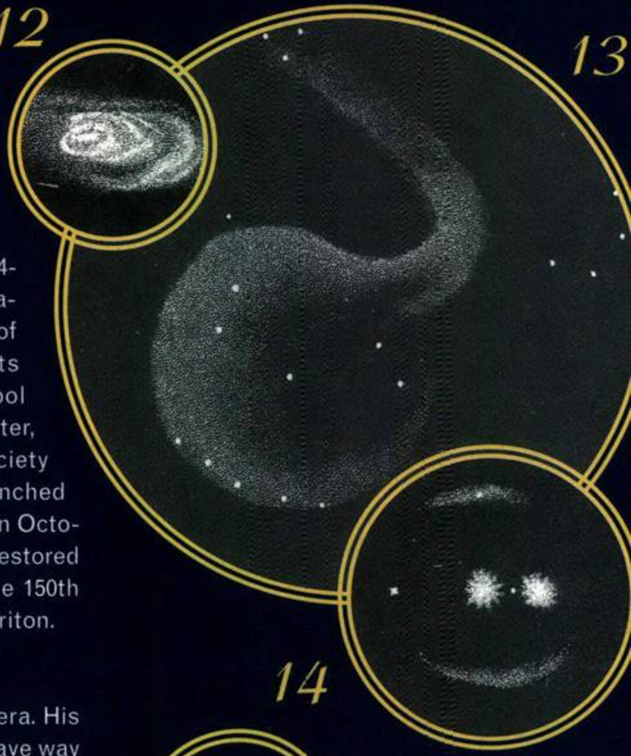
12 M88, a spiral galaxy in Coma Berenices
1862, May 21. This Nebula is of a somewhat convoluted form; it may be a spiral, but I cannot make it out. Power 285. With 466 I am unable to add any details to the drawing.

13 NGC 2359, a galaxy in Cancer
Viewed in March 1864.
A singular object. Many bright stars are in the field; power 210. Indeed, it may be said to be almost filled with a cluster of bright stars. I do not pretend to put them down with any precision in either position or magnitude, or even in number.

14 NGC 2371, a planetary nebula in Gemini
Viewed in March 1862.
A very remarkable small double Nebula or Planetary Nebula and stars; view with power 285.

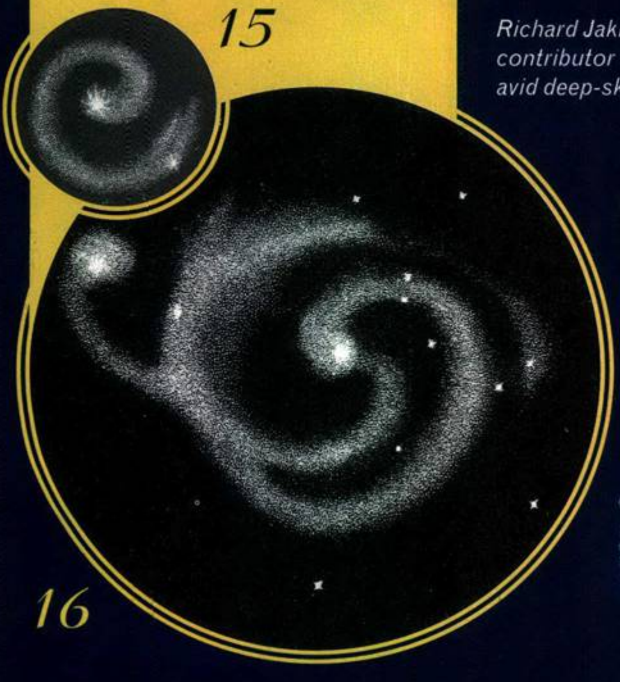
15 NGC 1042, a galaxy in Cetus
Viewed in November 1862.
A very obscure faint spiral nebula of apparently this form with power 760.

16 M51, the Whirlpool Galaxy, Viewed in June 1862. Chief Spiral Nebula
Surveyed generally, with 285, and the stars carefully placed by estimation in position and magnitude. Afterwards verified with 466, the faint stars being more plainly seen with that power. Viewed also 23rd June with 474, but the field of view was rather too small for the whole nebula.


12

13

14


15

16

marion backed Lassell's claim, which was finally upheld.

William Lassell died on October 5, 1880, of "weakness of the heart." His wife, Maria, died in April 1882. Daughters Caroline and Jane donated the 24-inch mirror to the Royal Observatory at Greenwich, while many of the 9- and 24-inch optical parts found their way to the Liverpool Museum. More than 100 years later, the Liverpool Astronomical Society and the Liverpool Museum launched the Lassell Telescope Project. On October 10, 1996, they dedicated the restored 24-inch Lassell Telescope on the 150th anniversary of the discovery of Triton.

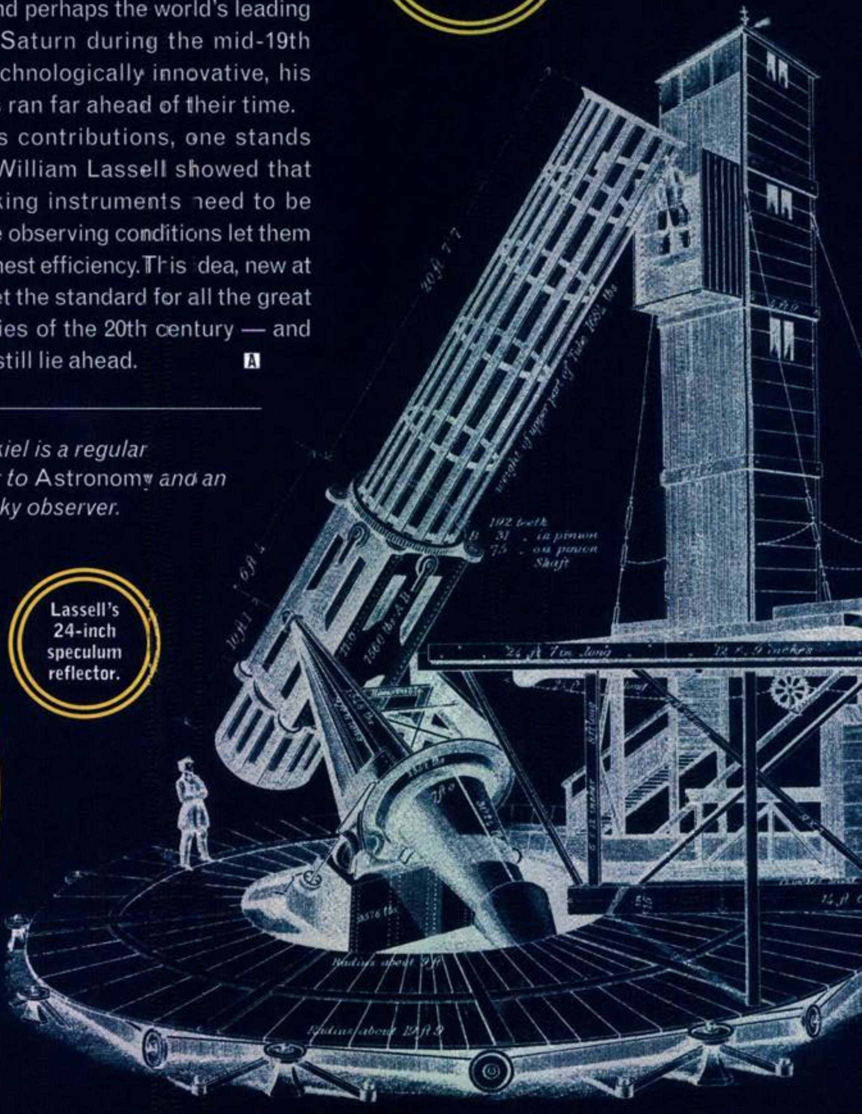
Lassell's Legacy

Lassell came at the end of an era. His kind of visual astronomy soon gave way to photography and the beginnings of astrophysics. But in the finest tradition of the great amateurs, Lassell made permanent contributions. He was a superb observer and perhaps the world's leading expert on Saturn during the mid-19th century. Technologically innovative, his telescopes ran far ahead of their time.

Of all his contributions, one stands foremost. William Lassell showed that path-breaking instruments need to be sited where observing conditions let them work at highest efficiency. This idea, new at the time, set the standard for all the great observatories of the 20th century — and those that still lie ahead. A

Richard Jakiel is a regular contributor to Astronomy *and an avid deep-sky observer.*

For more information, visit www.astronomy.com and click on the ***Astronomy*** magazine link.



Lassell's 24-inch speculum reflector.

HOT PRODUCTS FROM JMI

NEW! INSTAFOCUS FOR LX200GPS

(jimsmobile.com)

JMI'S NGFS WITH SMARTFOCUS

JMI SMART FOCUS 232

InstaFocus for the LX200GPS $139.95 ($6)

ETX AUTOSTAR
MEADE
ENTER
MODE
GO TO

NO SURFING FOR FOCUS MODE

InstaFocus hand control snaps onto the Autostar

POLAR ALIGNMENT SCOPE FOR 10" & 12" LX200 GPS $239.00 ($6)

Easily removed (No tools required) so scope can fit in the JMI cases.

The sensible alternative to scrolling through files every time you need to touch up focus or change eyepieces. Saves you lots of time. Does not plug into the Autostar. Motor plugs directly into hand control. Motor, batteries and cord included.

InstaFocus for the 90EC	**$119.95 ($6)**
InstaFocus for the 105EC	**$119.95 ($6)**
InstaFocus for the 125EC	**$119.95 ($6)**
InstaFocus for the LX-90	**$139.95 ($6)**
Motofocus for the LX-200 **Non GPS, Plugs into drive base**	**$109.95 ($6)**
InstaFocus for all NexStar SCT's	**$129.95 ($6)**

NEW

"Smart Focus 232" has arrived!

Smart people choose Smart Focus.

Use as stand-alone PC focuser or link to Maxim DL/CCD or CCDSoft for Auto Focusing **$339.00** ($5)

InstaFocus for the LXD 55 8" & 10" **$139.00** ($6)

InstaFocus for the LX200 GPS 10" & 12" **$139.95** ($6)

Polar Alignment Scope for 10" & 12" LX200 GPS **$239.95** ($6)

JMI'S MAX COMPUTERS NOW WORK ON 6", 8" & 10"ORION SKYQUEST SCOPES

ZERO Image Shift Focuser

NGF–DX1 2" with 1.25" adapter (lifts 8lb.) $259.00 ($7)
The DX1 is truly a masterpiece of engineering, workmanship and function with two different speeds. The finest action is 13 times more precise than most rack-and-pinion focusers

NGF–DX2 2" with 1.25" adapter (lifts 8lb.) $199.00 ($7)
2.5 times more precise than most rack and pinion focusers

NGF–DX3 2" with 1.25" adapter (lifts 6lb.) $159.00 ($7)
1.5 times more precise than most rack and pinion focusers

NGF–mini2 1.25"	**$129.00** ($7)
NGF–mini3 1.25"	**$99.00** ($7)
DRO (digital focusing)	**$229.00** ($7)
DFC	**$74.95** ($5)
MOTOR when ordered with focuser	**$110.00** (N/A)

"To put it bluntly, if there's a better line of commercial focusers made for imaging, I don't know about it."
–Dennis di Cicco
3/94 Sky & Telescope

LX90 Case

Finder Scope storage vinyl cover included
ALL JMI CASES HAVE DIE CUT FOAM

Custom Designed By JMI

$269.95 **($16)**

Sleek & Compact, with wheels

FOAM LINED CARRYING CASES

ETX-90, ETX-90EC	**$ 99.95** ($7)
ETX-125 EC	**$139.95** ($8)
LX90 8"	**$269.95** ($16)
NEXSTAR 5, NEXSTAR 4	**$139.95** ($8)
LX200 8" GPS & NON-GPS	**$269.95** ($16)
NEXSTAR 8	**$269.95** ($16)
NEXSTAR 8" GPS	**$379.95** ($29)
NEXSTAR 11" GPS	**$379.95** ($29)
LX200 10" GPS & NON-GPS	**$379.95** ($29)
LX200 12" ***GPS NEW LOW PRICE***	**$499.95** ($29)

Schmidt-Cassegrain Focuser

NGF–S for SCTs - This special version of our NGF focusers fits directly onto 2" thread of Meade and Celestron 8"-14" Schmidt Cassegrain telescopes.

Manual version of JMI's famous Zero–Image–Shift NGF–S focuser

NGF–SE Manual Focuser $169.00 ($7)

MOTOR and DRIVE TRAIN SO SUPERIOR TO OTHER MANUFACTURES, ONLY NGF-S CARRIES A 5-YEAR WARRANTY
NGF–S w/built-in MOTOR $279.00 ($7)

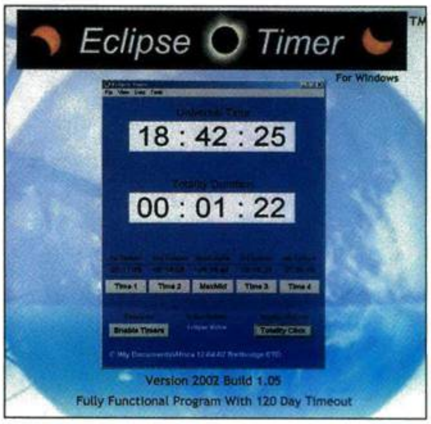
Call Now!
1-800-247-0304
Visa & Mastercard accepted.

Prices are subject to change

(jimsmobile.com)

Jim's Mobile Inc - 810 Quail St., Unit E - Lakewood, CO 80215 - Orders: 800-247-0304 - Info: 303-233-5353 - Fax: 303-233-5359

PRODUCTS


Eclipse Timer
TM
For Windows
18 : 42 : 25
00 : 01 : 22
Time 1
Time 2
MaxMid
Time 3
Time 4
Enable Timers
Totality Click
Version 2002 Build 1.05
Fully Functional Program With 120 Day Timeout

Eclipse Timer

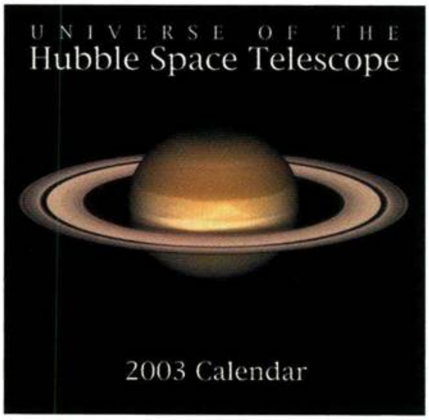
▶ In astrophotography, timing is everything. If you are unprepared during the fleeting moments of a solar eclipse, such as the one visible this month from Australia and Africa, the opportunity will be lost. Now, with software designed to act as a photographer's assistant, you'll always be poised and ready to shoot. Called *Eclipse Timer*, the software allows you to program reminders — announced in a human voice — of upcoming photo ops such as contact times and totality. You can even request that the program make a clicking sound every 10 seconds to help pace exposures. *Eclipse Timer* comes on CD-ROM in two formats: One runs on a Windows platform for PCs, the other on Microsoft Pocket PC 2002 for handheld devices with StrongARM processors. Each version sells for $49.

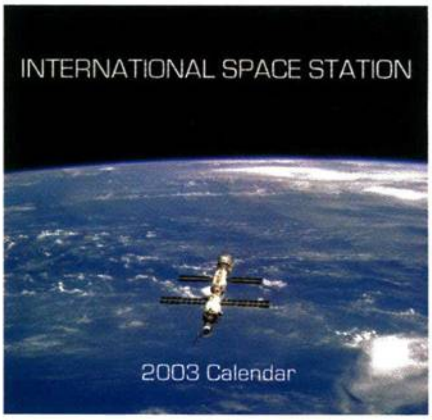
Visit the *Eclipse Timer* website at www.eclipsetimer.com.

PRODUCT INFO

Suppliers should send announcements and color photographs to Star Stuff, P.O. Box 1612, Waukesha, WI 53187, or e-mail starstuff@astronomy.com. *Astronomy* assumes no responsibility for the product information supplied by manufacturers. Prices are retail and subject to change without notice. Check *Astronomy*'s website for further product updates — http://www.astronomy.com.

Astronomy
Magazine
2003
CALENDAR


UNIVERSE OF THE
Hubble Space Telescope
2003 Calendar


INTERNATIONAL SPACE STATION
2003 Calendar

A Universe of Calendars

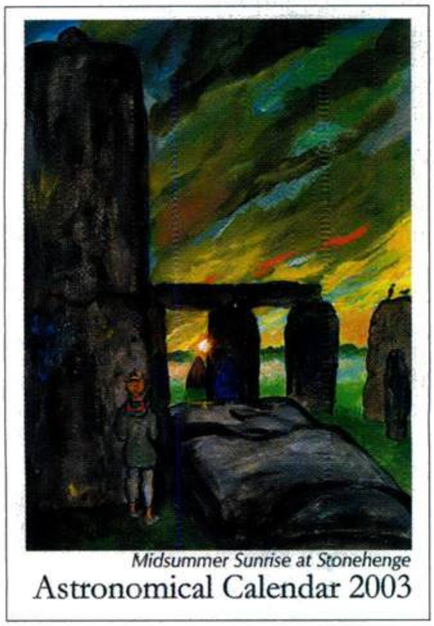
▶ It's that time of the year again — when seemingly every bank, gas station, supermarket, and passing stranger tries to unload a promotional calendar. And while these wares are useful enough, they rarely inspire.

Several new products offer more for astronomy lovers in 2003. *Astronomy*'s Senior Editor Richard Talcott has handpicked the most striking images of celestial objects for the magazine's new calendar, which includes seasonal star charts for year-round stargazing.

Key observing tips, such as the phase of the moon and when the planets are visible, are sprinkled throughout the year, and an in-depth description accompanies each month's featured image, from the physics of solar eruptions to an idealized landscape of a distant planet.

The *Universe of the Hubble Space Telescope, Earth from Space*, and *International Space Station*, three beautiful calendars from Astrographics Publishing, also bring you a fresh perspective on our cosmos. Full-color photographs of near and deep-sky objects, iridescent mountain ranges, and astronauts floating miles above the Earth grace the pages of each, along with annotated observing notes for most days.

For another information-packed resource, try the *Astronomical Calendar* by Guy Ottewell. Lacking the traditional grid of days, this oversized book is less a day planner than an almanac for



EARTH from SPACE
2003 Calendar

observers. For each month there is a map of the evening sky and a diary of about forty observable events, along with supplementary sections on the planets, occultations, and more. Published annually since 1974, the book retains a personable, folksy tone.

To order the *Astronomy* calendar, which sells for $11.99, call 1-800-533-6644, or visit www.astronomy.com.

For any of the Astrographics calendars, call 1-888-8-ASTRO-8, or visit www.astrographics.com. By mail, send $12.95 per calendar plus $3.95 shipping to Astrographics, 85 Oakside Drive, Smithtown, NY 11787.

To order Guy Ottewell's *Astronomical Calendar*, call 1-888-432-2264, or visit www.universalworkshop.com. By mail, send a check or money order for $24 plus $5 shipping to Universal Workshop, P.O. Box 426, Middleburg, VA 20118.

BOOKS

Setting Sail for the Universe: Astronomers and their Discoveries

Donald Fernie, 192 pages, Rutgers University Press, New Brunswick, New Jersey, 2002; ISBN 0-8135-3088-1; hardcover, $25.

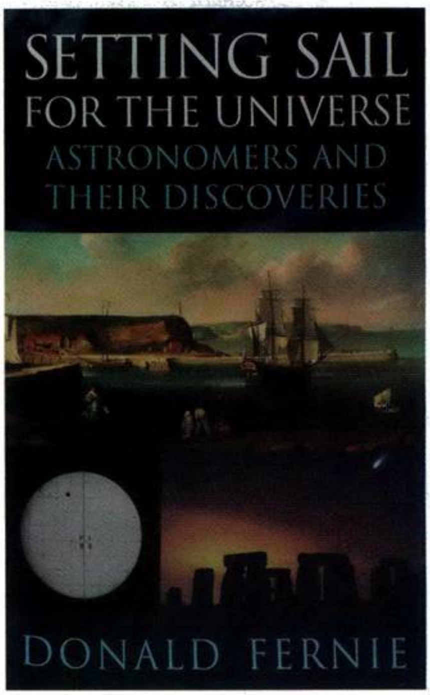
▶ In bygone days, astronomy was quite the risky business. Astronomers of past centuries routinely braved far more than eyestrain and drowsiness to make key measurements or witness pivotal events, crossing enemy-laden seas, hacking through jungles, or enduring wasp attacks just to view the right bit of sky. In fact, the 18th-century British always sent a backup astronomer on trips in case the first was killed. Those who did stay at home performed hours of painstaking calculations for problems solved with a few keystrokes today.

It is this world of meticulous persistence and Indiana Jones-style stargazing that Donald Fernie, founder of the astronomy department at South Africa's Cape Town University, brings alive in his latest book on the history of astronomy, *Setting Sail for the Universe*. The book comprises updated essays selected from nearly 20 years of his "Marginalia" column in *American Scientist* magazine.

The essays delve into the history of scattershot problems that once stumped the astronomical community, including the tetchy disputes, dead-end leads, and arduous journeys that preceded the discoveries we now take for granted.

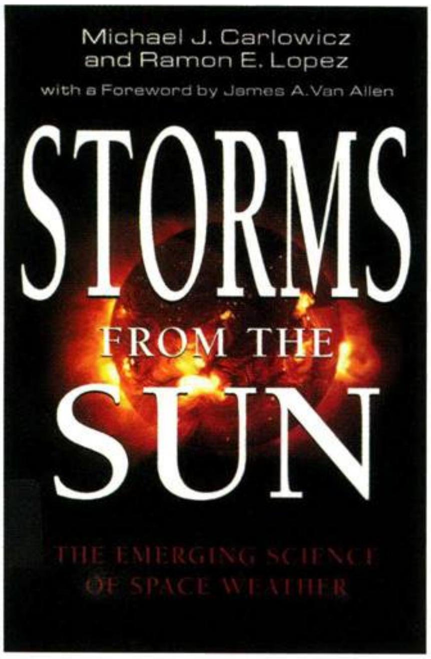
We meet people who, with the simplest of instruments, tried to answer the burning questions of their day: What is the shape of Earth? How large is the solar system? Does a mysterious unknown planet, Vulcan, lurk between Mercury and the Sun?

Fernie gives the reader juicy glimpses of the personalities populating the history of astronomy, including such forgotten geniuses as Jeremiah Horrocks, who might have rivaled Newton had he lived past 22. More familiar names such as Edmond Halley, who will forever be associated with comets, become fleshed-out, three-dimensional characters. He comes across as a jovial man of tremendous intellect. Once, in fact, he was game enough to find himself lurching along in a wheelbarrow piloted by Russian emperor Peter the Great, who later pitched him into a holly hedge at one of the emperor's rowdy parties. We even hear of Fernie's own spooky encounter with "the ghost of the 100-inch" in the wee hours of observing on California's storied Mount Wilson.



At times, Fernie gets carried away with the finer points of his scientific histories. He peppers some chapters with enough calculations and accompanying jargon to leave the casual hobbyist or interested novice in the dust. While a professional astronomer might share his amazement (he inserts charming exclamations like "horror of horrors!" before surprising solutions), excerpting some sections as footnotes would have worked better. This would satisfy the curious, while allowing those with rustier math knowledge to skip over the tough stuff.

Although occasionally bogging down in detail, the collection is liberally sprinkled with interesting facts and engaging anecdotes. Fernie's storytelling definitely evolved over the years to emphasize, as he says, the "very human side to astronomy." — *Jessa Forte Netting is a science writer who has written for* Science News, Nature, Popular Science, *and* Scientific American.



Storms from the Sun: The Emerging Science of Space Weather

Michael J. Carlowicz and Ramon E. Lopez, 256 pages, Joseph Henry Press, Washington, D.C., 2002; ISBN 0-3090-7642-0; hardcover, $27.95.

▶ At first thought, "space weather" sounds like a tired plot device from the Flash Gordon era. But space weather is real. And it's actually so vital that both the military and the National Oceanic and Atmospheric Administration (NOAA) monitor the Sun, responsible for most of the solar system's space weather, 24 hours a day.

Storms from the Sun is an insider's view into this little-known science. Author Michael Carlowicz spent five years working with solar scientists and spacecraft engineers at NASA's Goddard Space Flight Center, and co-author Ramon Lopez, a professor at the University of Texas, is intimately involved with the National Academy of Science's Decadal Survey of the twin fields of solar and space physics.

With the delivery of a fireside chat, Carlowicz and Lopez offer a thorough — and often witty — explanation of the Sun's sometimes surprising impact on Earth, driving their points home with photographs that illustrate the solar system's haunting beauty.

They hook readers with a blow-by-blow account of two dramatic solar events in 1998 and 2001 that made international waves. One knocked out pager and credit card service throughout the United States; the other threatened space-walking astronauts outside the Space Shuttle.

Despite the recent upsets, the effects of space weather have been noted since antiquity. Comet tails, aurorae, and sunspots are all signs of the steady wind of charged particles and blast waves that emanate from the Sun.

Sunspots, blemishes on the face of the Sun that are up to several times as big as Earth, are caused by the Sun's powerful magnetic field. They're associated with giant, Jupiter-sized "active regions," magnetized hot spots in the tenuous, ultra-hot corona that forms the Sun's outermost surface. The active regions themselves carry titanic electric currents that periodically short out, causing the largest explosions in the solar system, solar flares.

The authors describe the effects of solar events on earthbound electrical systems, our high-altitude magnetosphere, spacecraft, and astronauts. They cover the mysterious 11-year solar cycle of activity, the active research programs at NASA and the National Science Foundation, and future directions for space-weather-related investigations.

Storms from the Sun closes with a comprehensive reading list and an astounding array of Internet URLs, from educational sites to current x-ray images of the Sun. A homepage for the book (http://www.stormsfromthesun.net) makes it easy to write to the author.

Well-timed for the current wave of powerful solar flares at the close of the Sun's 11-year cycle, *Storms from the Sun* makes a useful reference for the curious lay person and a pleasurable daytime read for night-time observers. — *Craig DeForest is a senior scientist at the Southwest Research Institute in Boulder, Colorado. He studies the physics of magnetic fields in the solar corona.*

Nucleus: A Trip into the Heart of Matter

Ray Mackintosh, Jim Al-Khalili, Bjorn Jonson, and Teresa Peña, 160 pages, Johns Hopkins University Press, Baltimore, Maryland, 2002; ISBN 0-801-86860-2, hardcover, $29.95.

▶ Modern physics is hot on the trail of some of astronomy's most elusive questions: What exactly goes on inside stars? Why does matter take the forms it does? A welcome introduction to the quest can be found in *Nucleus*, a valiant attempt to convey the history, subject matter, and applications of subatomic research, and then place them in the context of astronomy — in 143 pages flat. Despite the volume's brevity, the authors are mostly successful.

Let the reader beware: *Nucleus* is very much a physics book that has leanings toward astronomy — not the other way around. Most of the writing that will interest the aficionado of astronomy alone is found in the last two chapters; but for those curious about both fields, the book is a fine starting point. The four authors are eminent nuclear physicists with a knack for explaining difficult concepts to the uninitiated.

Nucleus leads us through the esoteric world of subatomic research, from the discovery of x rays a century ago to the latest research in exotic particles. By the time readers reach the book's closing sections, they have some grasp of the forces at work in the stellar cauldrons that create the universe's heavier elements.

The book culminates with the applications of nuclear physics to astronomy. Chapter 9 presents an overview of how carbon, nitrogen, oxygen, and other elements are created from hydrogen and helium inside stars. Some of the heavier elements were forged within supernovae, the ashes from which sometimes fall to Earth as meteorites.

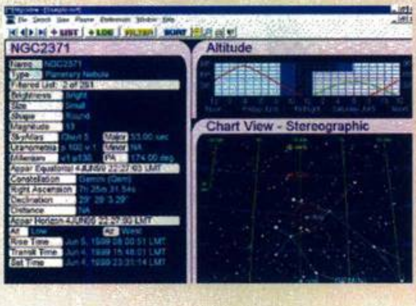
Chapter 10 describes the immediate aftermath of the Big Bang, when hydrogen and helium were born from a soup of elementary particles.

A book on this subject would be daunting without illustrations, and the authors provide a selection both profuse and enlightening. The writing is generally clear, and a few moments stand out: I have never read a better description of the "valley of stability," where the stable nuclear isotopes lie.

My one quibble is that related concepts are sometimes separated by several chapters, such as a section on deformed nuclei that appears 50 pages after its introduction. Had the authors included references to such previous discussions, I would have found the going easier. But anyone with an interest in the subject matter will want to read *Nucleus* several times, and the authors make the experience enjoyable. — *Chad Boutin is a science and technology writer living near Chicago.*

The Webweaver Picks

by Richard J. Bartlett



When it comes to deep-sky observing, many of us are like diners at a restaurant: We'll stick to our favorite meals, when we might do well to consider the full menu. What if the waiter could make hundreds of recommendations instead of only one or two?

That kind of selection is available to astronomers with session planners, databases that allow you to make the most of clear nights. The programs will search for the objects you wish to view, such as Messier galaxies or open clusters brighter than magnitude 10.

Three planners accessible online are the commercial products *NGCView*, *DeepSky 2002*, and *The Ultimate Messier Observer's Log*, which is more limited but has the advantage of being free.

If you're a Star Trek fan, then you'll love *NGCView*, whose design makes you feel like a crew member of the Starship *Enterprise*. Available for Windows 95/98/2000 and NT, a demo can be downloaded as a 4.8MB self-installing program from www.rainman-soft.com.

After 30 days the program ceases to function, so if you like it, you'll need to purchase the full product for $89.95. This is shipped on a CD-ROM that features 70 million stars and 200,000 deep-sky objects.

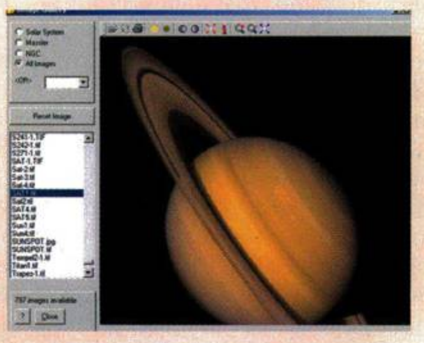
A number of handy filters and sorting routines help you select what to observe. For example, you can find out which galaxies between magnitudes 3 and 13 are visible from your home between 9 and 11 tomorrow night. Then you can order them with the brightest objects first.

Other handy features include a calendar showing when moonlight might be a problem, a night-vision display option, ASCOM telescope control, star charts, and your own observation logs. Perhaps best of all, a graph depicts the object's altitude compared to the Moon, useful when choosing the best time to observe. *NGCView* has a lot to offer deep-sky observers of all levels — it's quick and easy to use, with all the information on one screen.

DeepSky 2002 by Steven S. Tuma and Dean Williams can be downloaded as a limited program for $29.99 from the *DeepSky* site at www.deepsky2002.net. This version includes a database of 26,000 objects and lists stars up to magnitude 11. However, the WinZip file consists of approximately 60 MB. Be prepared to leave your computer connected to the Internet while you run errands.

The full product features 18 million stars; 4,000 observations from other astronomers; and a copy of the free planetarium program *Cartes Du Ciel*. Shipped as a CD-ROM, it costs $52.99 and runs on Windows 95/98/2000 or NT. It requires 80 MB of hard disk space and 32 MB of RAM.

Program features include search routines; a built-in star atlas; spreadsheets; observing plans; observation logs; planetary, cometary, and minor body data; an ASCOM telescope control; an image processor; and customizable printouts. One of five spreadsheets displays search results. With a click of the mouse you can see further details and a finder chart for a particular object. Then you can add the object to your observation plan, or amend notes to your log.



DeepSky 2002's strength lies in its spreadsheet style and the way each module within the program is interlinked. It's not for beginners, but if you love your scope and those clear dark nights, you'll want to treat yourself to a copy.

The last of our session planners, *The Ultimate Messier Object Log* (*TUMOL*) by David Paul Green, is available in a number of formats. The stand-alone application comes as a 3.1 MB WinZip file for Windows 95/98/2000, or a 3.1 MB Stuffit archive for Macs. If you've got a Palm Pilot or Handspring Visor, try the 12K version requiring JFile. The software is free and can be downloaded from the author's homepage at www.davidpaulgreen.com/software.html.

TUMOL is a simple FileMaker Pro database program that shows basic finder charts and images for each of the Messier objects. Each entry can be printed for use in the field and users can add their own observation notes for future reference.

Because the program was created with FileMaker Pro, it can't calculate the positions of solar system bodies or what objects are currently visible, so you'll need to be aware of the constellations observable that night.

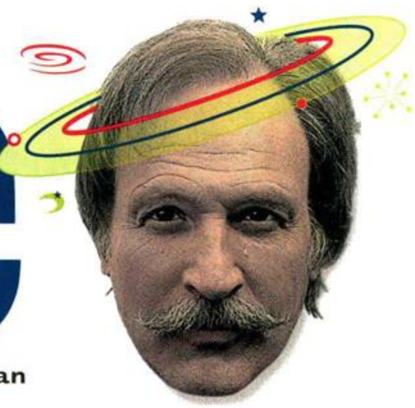
There's also no function to search for a specific type of object, so you'll need to manually go through each entry and make printouts. Using the program can be a little confusing at first, but a Help option explains each function and the observation notes.

The beauty of *TUMOL* lies in the way all the information can be printed on a single sheet of paper, making it ideal for star parties and Messier marathons. Aimed at amateurs of all levels, beginners will find the binocular difficulty rating and easy-to-follow star maps especially useful. If you have yet to venture into the Messier minefield, then *TUMOL* is a good place to start.

On the next clear, dark night, take the opportunity to sample all the deep-sky delights. Point your scope at the first star on the right — and carry on till the break of day.

— Visit Richard's StarLore site at http://www.starlore.net.

strange Universe



by Bob Berman

Holiday Gimme List

You know the holiday season is approaching when backyard astronomers start walking around with strange, greedy smiles. More goodies! More gadgets!

This is it! The opportunity to acquire just what you want, from friends and family who solicit hints about what you'd like for Christmas. A new tie? A sports jacket? My mom's pretty typical, still imagining I'm back in high school and that I might conceivably derive joy from finding a V-neck sweater under the tree. No, Mom, I *never* wanted clothes, especially the dull ivy-league outfits you would buy, admired only in alternate quantum realities. What I want now is the same thing I would have asked for 20 or 30 years ago. Gloves? No, but you're getting warmer. It's a narrow-bandpass H-α solar filter.

And that's the secret of getting the right astronomical trinket for Christmas (or Hanukkah, Kyomo, M'kenda, or Dwark). This applies to birthdays, too, and you can even squeeze out a celestial gift if you do the right amount of whining just prior to Father's, Mother's, or even Veterans Day, whatever your race, color, or creed (what IS creed, anyway?) or species, phylum, or ethnic food preference. Any excuse you can muster. The critical issue is: how to make those around you actively and financially support your curious fixation with gadgets and optics.

Oh sure, a few of us actually gaze at the night sky without any equipment, and drink in the ancient star patterns the way raccoons do. But, face it, we're the sick people, not the kind of astronomers beloved by advertisers. Well, maybe a few minutes of naked-eye observing is okay as a warm-up. But then it's time to roll out the optics, and here is where food stamps just won't buy what you need. The goal, as we all soon realize, is to do *something* to the universe. This begins by abandoning all simple serene observing and instead becoming proactive, as they say in education circles.

Stargazing is out. Too passive. Almost like watching TV. Learning the constellations and stars is better, because "learning" is an active verb, and the more active the verb, the more comfortable we'll feel in our revved-up culture. So an even better infinitive than "to learn" is "to blow up," as in "Hey, Mike, let's hook that 2mm eyepiece to this 3x Barlow and *blow up* Saturn to 1,900 power."

> *Here's how to organize a buy-me list of cosmic items, goodies, gadgets and toys.*

If you're smiling now, it's because you've been there, done that, and seen firsthand what high magnification does to celestial objects. It turns them into blurry blobs containing as much sharp detail as our politicians' coma-inducing speeches. If very high power is bad, but we desperately need to purchase equipment in order to be proactive, what do we do? What do we ask for? And, worse, what if we already have everything we need? (Ha-ha! Good for you: You recognized that as a trick question. In reality, no such need-nothing contentment ever exists among backyard astronomers except during low-probability rifts in the space-time continuum.)

First, realize that what you crave will fall into just one of four general categories: optics, accessories, learning aids, and cool or weird stuff.

Optics include binoculars, telescopes, eyepieces and the like. Warning: Some of the newer equipment on the market is so hard to resist, it shouldn't even be tried out. For example, I already owned four fabulous binoculars: Bausch and Lomb Customs (which is what my Park Ranger friends at Yellowstone preferred, during my 13 years of teaching astronomy there), fine Orion and Celestron 11x80s and 20x80s, and some old but trustworthy 7x50s. So I definitely didn't need another pair, right? Unfortunately, someone let me try out their new Canon image-stabilized binoculars. Bad news. You try them, you'll sell your kids for them. They're that good. Since they aren't cheap, the solution is obvious: Don't touch them in the first place. Just say no.

The second category includes both digital and film cameras, and there's no end to their variety. With CCDs, image manipulation software, and a hard drive, you can capture, enhance, and later present a nebula in psychedelic colors that resembles what you actually saw through the eyepiece to the same extent that the thick juice-dripping burger in the drive-up display matches the biopsy-thin brownish substance tossed to you in the bag.

The third group, educational stuff, includes subscriptions to *Astronomy*, books, computer programs, all the things you play with when it's cloudy. You definitely need these too, if you're to be up on basic and esoteric knowledge that allows you to explain what exactly a "Serpent Bearer" does, or define "Sea Goat" the next time a beautiful woman at a bus stop walks over to ask about the constellations Ophiuchus and Capricornus.

In the realm of the cool and weird we find the new last-forever red flashlights, and expensive green lasers that can be used as pointing-beams to the constellations and help turn the rural sky into a planetarium. And orreries and portable atomic clocks and GPS handheld units, which are way cool although you probably will never find an astronomical use for them.

Finally, if you do give or get a telescope this holiday season, remember that no one telescope is perfect, and yet all of them are. (It's wonderful to obnoxiously toss out Confucius-sounding stuff like that.) But it's true.

Buying the cheapest large-mirrored Dob gives you enormous light-gathering at a great price, along with lifelong frustration at the low-tech mounting and lack of tracking. If you choose a high-tech Maksutov bristling with Apollo-like dials, there's no money left for a large mirror. Purchase an 8-inch SCT and you'll have a good instrument with excellent portability, but lowered image contrast because of the large secondary mirror. Get a long-focus, 8- or 10-inch, f/6 to f/8 Newtonian and you'll view fabulous images but have a hard time toting it anywhere. Buy a 4- or 5-inch refractor that's hassle-free and optically exquisite, but you're back to a smallish aperture.

Every telescope involves compromise. You can't have it all. Don't set yourself up for later discontent: Decide what your primary needs are, buy or hint accordingly, then never look back. And just maybe your holiday will deliver a celestial treat that sends you outdoors to experience what the season was traditionally meant to bring: the tranquil contemplation of the grandeur of it all. ◼

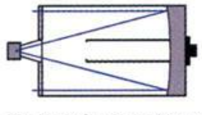
Bob Berman's column, "Strange Universe," appears each month in Astronomy, *bringing the wit and wisdom of a true dark-sky aficionado.*

HyperStar™
High-Speed CCD Imaging

Now available for all Fastar-compatible Celestron SCTs

The HyperStar system allows CCD imaging at an amazing f/1.8 focal ratio (f/1.9 on 14" scopes). Images which might otherwise take hours now require just a matter of seconds! Plus, the wide field of view encompasses many large deep-sky objects normally not available to CCD imagers using SCTs.

6-minute HyperStar exposure of M20 with NexStar 11 GPS



The HyperStar lens allows a CCD camera to be mounted at the front of a Celestron Fastar-compatible SCT.

The HyperStar 8 and 11 models are ideal for high-speed CCD imaging with the NexStar GPS series of telescopes.

For the ultimate CCD imaging system, the HyperStar 14 is compatible with large-format CCD cameras, providing tack-sharp star images across an incredibly wide field!

★ *Available exclusively at Starizona* ★

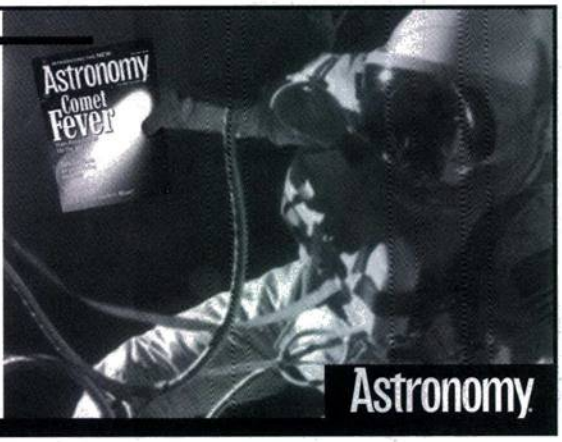
Visit www.starizona.com/hyperstar for more details and images

Simply out of this world

Order your subscription today!

Call 1-800-533-6644

Astronomy.com



Astroshops.com

Compare hundreds of products in one convenient location!

Featuring these fine stores:

AstronomyQuest.com

Hardin Optical
The Astronomy Company

OPT Oceanside Photo & Telescope

Excellent prices

Reviews and recommendations

AC_37939AD15

Beginner's sky

Cosmic adventures for the neophyte astronomer. By Glenn Chaple

Brrrrr! It's December, which for many of us observers means bracingly cold nights. If the call of a warm den starts to melt your resolve to stargaze, block out its siren song with a pair of earmuffs. The winter skies are filled with beautiful and fascinating sights — just bundle up and you'll overcome the season's big chill.

Also, remember that astronomy should be fun, not a test of your endurance. Keep your observing sessions short and sweet, especially if you're sharing your sky adventures with someone who might not be as cold-tolerant as you. I recommend a half-hour or less under winter skies, followed by a warm mug of hot chocolate back indoors. But on those evenings when the weather is downright brutal, heed the call of the couch. You can still enjoy astronomy — armchair style, that is. Here are my recommendations for a great winter read.

Astronomy For Dummies, Stephen P. Maran
336 pages, John Wiley & Sons, New York, 1999; ISBN 0-7645-5155-8; softcover, $19.99.
OK, so the title is a bit insulting, but either this or the book below is a handy guide not only for "dummies" and "idiots," but for geniuses, as well. Your cosmic adventures will have more meaning if you have a clear idea of what's up there in space. These books make learning astronomy easy.

The Complete Idiot's Guide to Astronomy, Second Edition, Christopher De Pree and Alan Axelrod
456 pages, Alpha Books, New York, 2001; ISBN 0-0286-4198-1; softcover $18.95.

365 Starry Nights: An Introduction to Astronomy for Every Night of the Year, Chet Raymo
Some 225 pages, Fireside, New York, 1990; ISBN 0-6717-6606-6; softcover, $16.
Before you can explore the night sky with binoculars or a telescope, you need to be able to identify the basic constellations and bright stars. If you want to learn what's up there at an easy, relaxed pace, *365 Starry Nights* is the way to go. Author Chet Raymo teaches you the night sky one night at a time, focusing on the constellations but also offering a few targets for binoculars and scopes. By year's end, you'll be navigating the stars like a pro.

Nightwatch: A Practical Guide to Viewing the Universe, Third Edition, Terence Dickinson
172 pages, Firefly Books, Toronto, 1998; ISBN 1-5520-9302-6; hardcover, $29.95.
A great all-around astronomy guide, *Nightwatch* includes well-illustrated sections on identifying seasonal constellations and using binoculars and telescopes.

Snow White and the Seven Sisters

When the mercury drops and snow blankets the ground, you'll want a few sky targets that are easy to spot on a quick dash outdoors. I first saw one of my favorites on a magical late-autumn night when I was about 10. (It's burned in my mind because I had just watched *The Wizard of Oz* on TV and when I went outside, I saw something far more enchanting than Munchkins or a yellow brick road.) There in the sky was a tiny cluster of stars sparkling like diamonds. I was captivated by their delicate beauty. The stars were arranged in the form of a miniature dipper, and it occurred to me that this might be the Little Dipper constellation my teacher had told us about in school.

It wasn't. Years later, I learned that this "Little Dipper" was actually a star cluster known as the Pleiades, or the Seven Sisters, and that it resides in the constellation Taurus. (It also bears the name Messier 45, though I'll introduce you to the Messier catalog another time.) One of the nearest of hundreds of open star clusters in our galaxy's spiral arms, it comprises relatively young stars, formed when a huge cosmic gas cloud, called a nebula, contracted. Some faint, wispy traces of nebulosity remain around this stellar nursery.

Finding the Pleiades won't be a problem (remember, a 10-year-old boy found it without even trying). Just go outside about an hour after sunset — preferably on a clear, moonless night — face east, and look up.

Try counting the Pleiades — no fair using binoculars or a telescope. Eagle-eyed observers in dark skies have claimed to see a dozen or more stars, but the standard count for most of us is six. The whereabouts of the "seventh sister" remains a mystery. Perhaps one of the Pleiades has faded from naked-eye visibility since ancient times. Binoculars really bring the cluster to life, with close to two dozen members popping into sight. But most telescopes fail to do the Pleiades justice. Sure, you'll see more than a hundred stars, but the whole cluster won't fit in the field of view — one example of why you don't always need a powerful scope to enjoy the night sky.

So bundle up and go enjoy one of the finest wonders of the night sky (you can really set the mood by watching *The Wizard of Oz* beforehand). The sight will warm your heart — even if it can't help the rest of your body.

Glenn Chaple teaches middle-school science and adult-ed astronomy classes in Townsend, Massachusetts.

The Pleiades star cluster forms a tiny dipper above the waterfall at right. If you follow the dipper's handle downward, you'll see the V-shaped Hyades star cluster, which forms the head of the bull in the constellation Taurus.

Target Taurus

cut along dotted line

Jerry Schad

Ideal for your home or office!

Astronomy magazine's 2003 calendar presents striking images of dramatic celestial observations. Features data on viewing many celestial events and seasonal star charts. Recognizes national holidays. 13 x 10½. Item #68125

1-800-533-6644

Mon–Fri, 8:30am–5:00pm Central Time
Fax 262-796-1615 • Outside the U.S. and Canada, call 262-796-8776

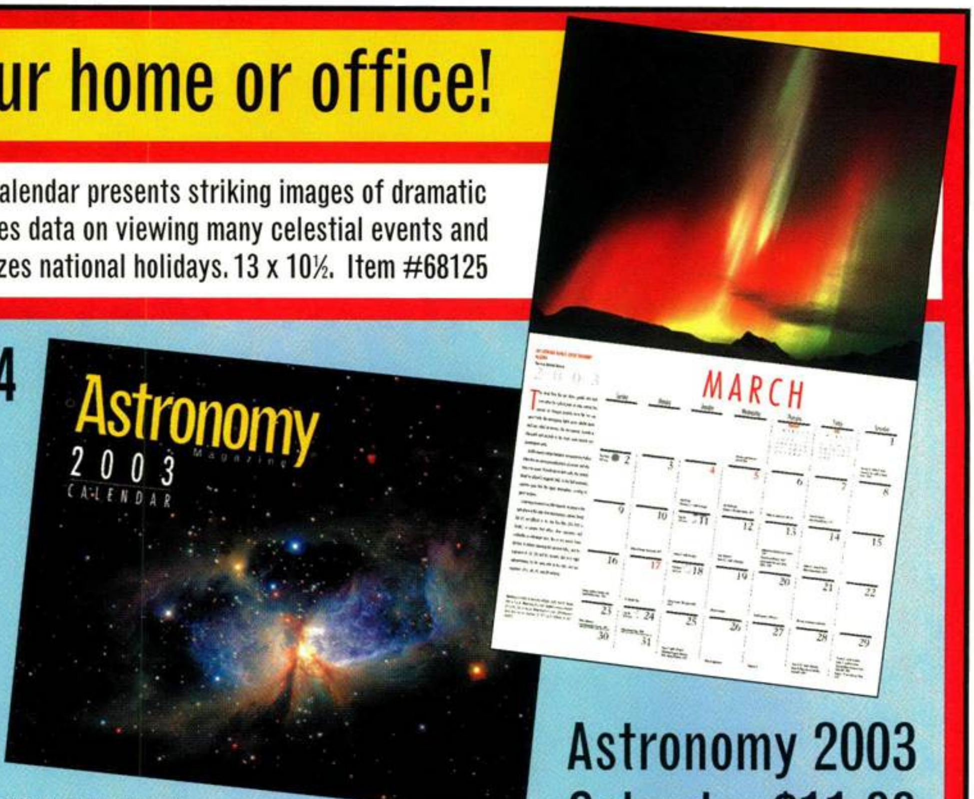
Order online:
astronomy.com

To order by mail: Send your order to: Kalmbach Publishing Co • Dept. A2000, 21027 Crossroads Circle • P.O. Box 986 Waukesha, WI 53187-0986

Include for shipping and handling:

Merchandise Total	Add for S&H
$15.00 or less	$4.95
$15.01-30.00	$5.50
$30.01-50.00	$6.50
$50.01-75.00	$7.50
over $75.01	$8.50

Canada add an additional $2.00, other foreign add an additional $5.00. For Wisconsin delivery, add 5% sales tax to total; Pennsylvania add 6% sales tax to total. For delivery in Canada add 7% GST to total. Payable in U.S. funds. Prices and availability subject to change.



A30332AD

Astronomy 2003 Calendar $11.99

A2000

Web Site Directory

Check out these businesses...They're only a click away!

ANALYTICAL SCIENTIFIC
asltd@analyticalsci.com
www.analyticalsci.com
Largest selection of telescopes in TX. Meade, Celestron, Tele Vue. Science, nature, educational items.

BERGER BROS.
CAMERA, VIDEO, DIGITAL
scopes@berger~bros.com
www.berger-bros.com
1-800-262-4160
Over 50 years of sales and service at the best possible prices.

KHAN SCOPE CENTRE
khan@khanscope.com
www.khanscope.com
New, used. Free newsletter.
3243 Dufferin St.,
Toronto-Ontario, Canada

Roger W. Tuthill, Inc.
sales@tuthillscopes.com
www.tuthillscopes.com
Retail sales of telescopes and accessories including our patented solar filters. Over 25 years experience!

ANDROMEDA SOFTWARE INC.
COMPLETE ONLINE CATALOG
andromedasoftware.com
Astronomy & Science
CD-ROMS for IBM & Mac
Since 1985

EFSTONSCIENCE
sales@telescopes.ca
www.telescopes.ca
Science & Astronomy SuperStore.
Canada's best prices and selection serving observing since 1970.

OWL SERVICES
owl1@postoffice.ptd.net
www.owlservices.com
Special prices on KONUS telescopes - binoculars!
FREE # 1-888-OWL-WARE
10-5 EST M-F

TALSCOPES
sales@talscopes.com
www.talscopes.com
Talscopes is the exclusive N. American master distributor for astronomical products produced by Novosibirsk in Russia.
Visit us at: www.talscopes.com

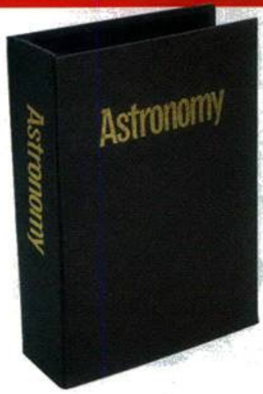
ASTRONOMY.COM
OnlineEditor@astronomy.com
www.astronomy.com
The site is designed for enthusiasts of any interest level who want to learn about astronomy.

KEN'S RINGS & THINGS
kendauzat@kricket.net
http://users.kricket.net/ken
Custom Rings, C-G 5/G-P Milled Dovetail Bars, KD Piers, 3-N-1 Bracket, Tube Handles, etc.
Send SASE to: 599 HWY 453
Marksville, LA 71351, for FREE flyer

PENNY PRODUCTIONS
www.PENNYPRODUCTIONS.com
Oversized Solar System Poster & Other Specialized Posters

For Advertising Information
Call Ken Kozerski at
1-888-558-1544 ext. 636

PROTECT YOUR INVESTMENT!



Preserve your library of ASTRONOMY Magazines with durable hardcover binders.

ITEM NO. 14007
1 for $12.95 • 3 for $35.95
5 for $54.95

Order yours today!

TO ORDER BY MAIL: Send your order to Kalmbach Publishing Co., Dept. A1975, 21027 Crossroads Circle, P.O. Box 986, Waukesha, WI 53187-0986. Use chart below for shipping & handling charges.

MERCHANDISE TOTAL	ADD
$15.00 or less	$4.95
$15.01–$30.00	$5.50
$30.01–$50.00	$6.50
$50.01–$75.00	$7.50
Over $75.00	$8.50

Canada add an additional $2.00, other foreign add an additional $5.00. For Wisconsin delivery, add 5% sales tax to total; for Pennsylvania delivery, add 6% sales tax to total. For delivery in Canada add 7% GST to total. Payable in U.S. funds. Checks must be drawn on a U.S. bank except for those from Canada; GST included. Make checks payable to Kalmbach Publishing Co. Prices and availability subject to change.

call 800-533-6644

Mon–Fri, 8:30am–5:00pm Central Time.
Outside the U.S. and Canada, call 262-796-8776.
Please have your credit card ready.

fax 262-796-1615

www kalmbachbooks.com

Secure online ordering available.

Astronomy

A38779AD A1975

NEXT month in Astronomy

Lynette R. Cook

UNDER ALIEN SKIES

Have you ever wondered how the sky might appear from other locations in the galaxy? Here's how such "alien skies" might differ from our own.

MARS ON EARTH

Space scientists hope to land humans on Mars by 2020. But an ongoing experiment in Utah shows they still have a lot to master.

TRANSITSEARCH.ORG

A new observing program, based on CCD cameras, lets backyard astronomers join the search for extrasolar planets.

COMET HUNTERS

Competing with robotic telescopes that are constantly scanning the skies, amateur comet hunters are yielding results through persistence.

Subscribe Today!

800-533-6644

Order online at

Astronomy.com

EXPLORE THE NIGHT SKY!

CELESTRON
MEADE
ASTROSCAN
TELEVUE

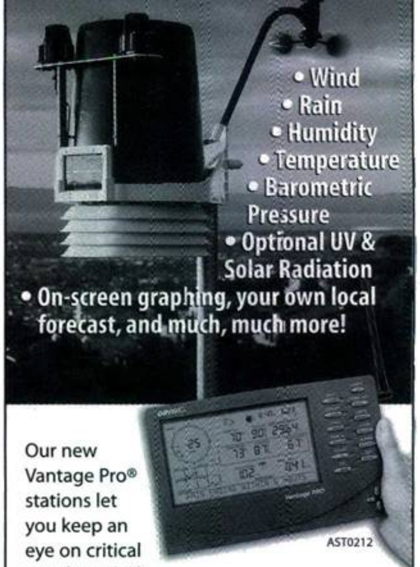
Order Online or Call Toll Free
800-728-6999 for FREE CATALOG

www.scientificsonline.com

Dept. D021-C821
60 Pearce Ave., Tonawanda, NY 14150
Fax: 800-828-3299
E-mail: cons_order@edsci.com

Edmund Scientific's
SCIENTIFICS®

Vantage PRO®
Wireless Weather Station



- Wind
- Rain
- Humidity
- Temperature
- Barometric Pressure
- Optional UV & Solar Radiation
- On-screen graphing, your own local forecast, and much, much more!

Our new Vantage Pro® stations let you keep an eye on critical weather conditions. Add our optional data logger and PC software for even more analysis. Wireless or cabled, starting at just $495!

AST0212

Order now, or ask for your FREE catalog.

Davis Instruments
3465 Diablo Ave, Hayward, CA 94545
800-678-3669 • www.davisnet.com

Astronomy's Marketplace

Welcome to the MARKETPLACE section in ASTRONOMY Magazine. These pages are specifically designed to be an affordable and highly effective way for you to market astronomy-related products or services. Call Ken Kozerski at 888-558-1544, ext. 636 to place your advertising message here.

2sky
dynamic astronomy
for Palm®
handhelds
www.in2space.com

NO TOOLS!
$16 SHIPPED WORLDWIDE

Bob's Knobs
Easy Collimation for
Meade & Celestron SCT
Morrow Technical Services
6976 Kempton Rd.
Centerville IN 47330 USA
765-855-5109
www.bobsknobs.com

Astrotec Low Prices Long Island, NY
CELESTRON•MEADE
Lumicon • JMI • Kendrick • TeleVue • Orion
http://www.astrotecs.com
4132 Sunrise Hwy.
Oakdale, NY 11769
Tel: 631-563-9009
Fax: 631-563-9018

OWL SERVICES

Your Best Source for
Konus Telescopes
SAC CCD Cameras
Knight OWL Eyepieces

Eyepiece Prices
40 or 30 mm - $28.
25, 20, 15, 12.5 mm,
or 2X Barlow - $26.
10, 6.5, and 4 mm - $25.
Special Prices on SAC Cameras - $199 to $249
Special on Konus RFT 4.5" Reflector $179. with Clock Drive, EQ Mounting, 3 Eyepieces & Finder!

OWL Services
5950 Keystone Dr.
Bath, PA 18014

Toll-free Phone Number: 1-888-OWL-WARE
Web Site - http://www.owlservices.com

THE OBSERVATORY

The Most Complete Telescope Store in Texas
TELESCOPES • MICROSCOPES • BINOCULARS
In the field set-up & instruction with every Astronomical Telescope purchase.

Astronomical Telescopes • Spotting Scopes
Binoculars & Giant Binoculars • Sky Charts
Atlases, Books • Computer Controlled
Telescopes • Astronomy Software

Celestron, Meade, Orion, Tele Vue®, Geochron, Canon, Swift, Spherical Concepts, Fujinon, Home-Dome by Technical Innovations

19009 Preston Rd., Suite 114 • Dallas, TX 75252
Located between Frankford & The George Bush Turnpike (Hwy. 190)
(972) 248-1450 • www.TheObservatoryInc.com

LUMICON®

THE BEST FILTERS IN THE UNIVERSE!!

For 1.25" and 2" Eyepieces

Lumicon Deep Sky, UHC, OIII and H-Beta Filters

Also: LumiBright Star Diagonals, Enhanced Aluminum Diagonals, Adapters, Hypered Film, HyperKits™, Multiple Filter Selector, Solar Prominence Filters, Super Finders, Sky Vector Digital Setting Circles, Coma Correctors, Piggyback Mounts, Vinyl Caps, Plugs and much more!!

Open Monday/Friday 9-6 PST
CALL FOR FREE CATALOG

LUMICON, 6242 Preston Ave.
Livermore CA • 94551
925-447-9570/925-447-9589 FAX

SKYWATCHER'S INN

THE ARIZONA
ASTRONOMY AND
NATURE RETREAT

BED AND BREAKFAST at the
VEGA-BRAY OBSERVATORY
New, modern, and comfortable lodging.
Many **TELESCOPES** from 6 to 20 inches, computer slewing and **CCD** imaging.
Science museum and planetarium.
DARK SKIES AND SPARKLING DAYS.
47 miles east of Tucson, 28 miles from Tombstone.
Close to many astronomical observatories, historical and natural attractions including Kartchner Caverns.
By appointment only: Tel/fax: (520) 615-3886
11331 East Placida Rancho Grande • Tucson, Arizona 85730-5808
http://www.communiverse.com/skywatcher
E-mail address: vegasky@earthlink.net

Entry Level, 24 bit color,
Long exposure CCD Imaging
Starting at $369
SACIV $199

SAC Imaging
321-259-6498
www.sac-imaging.com

SUNSPOTTER®

THE SAFER SOLAR TELESCOPE

"It's a clever device, an easy and extremely portable way to view the sun."

— *Jim Manning, Taylor Planetarium, and Associate Editor,* The Planetarian

- convenient, easy to set up, fun to use and a much safer way to view the light of the sun compared to more common methods.
- enables the user to track sunspots as they appear, move, and vanish and to make hourly and daily comparisons.

LEARNING TECHNOLOGIES, INC.
40 CAMERON AVENUE • SOMERVILLE, MA 02144 USA
TEL: 800-537-8703 OR 617-628-1459 • FAX: 617-628-8606
E-MAIL: SUNSPOTTER@STARLAB.COM • WWW.STARLAB.COM

STI

Series IV 'Stiletto' Focusers for 35mm & CCD Cameras

*Precision Focusing
*Upgradeable
*Completely Modular
*Easy to Use
*30-day Clear Sky Guarantee
*Ronchi Rulings & Knife-Edge

1-800-232-9416
www.stellar-international.com

TELESCOPES.COM

The new Takahashi TSA-130.

The newest Takahashi refractor, the triplet TSA-130, is the first of the new Ortho-Apochromat Series.

Available now at Telescopes.com

1-800-246-6285

You Save $929.00

$5265.75

nisur systems **Limited SALE!!**

Capella II altaz.-$99.00

Tripod Converter-$19.95

Mounts - P3 Tri-piers

Accessories

order-info - 973 790 5555

http://nisursystems.com

Reach for the Stars...the safe way

With *TRI SCOPE!*

WWW.TRISCOPE-LLC.COM

Green Laser Pointer

points out the stars

www.**betapointer**.com

phone 800.546.2382

ASTRO-AUCTION

BUY • SELL

NO FEES

Space Art

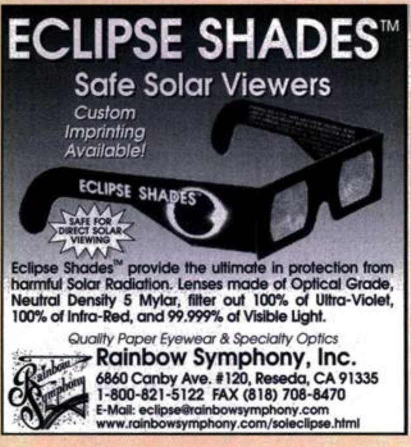
Telescope

Equipment

Meteorites

More

astro-auction.com



ECLIPSE SHADES™

Safe Solar Viewers

Custom Imprinting Available!

Eclipse Shades™ provide the ultimate in protection from harmful Solar Radiation. Lenses made of Optical Grade, Neutral Density 5 Mylar, filter out 100% of Ultra-Violet, 100% of Infra-Red, and 99.999% of Visible Light.

Quality Paper Eyewear & Specialty Optics

Rainbow Symphony, Inc.

6860 Canby Ave. #120, Reseda, CA 91335

1-800-821-5122 FAX (818) 708-8470

E-Mail: eclipse@rainbowsymphony.com

www.rainbowsymphony.com/soleclipse.html

CAMERA BUG

TELESCOPES • BINOCULARS

ACCESSORIES • EYEPIECES

SPOTTING SCOPES

MAPS • BOOKS • SOFTWARE

Canon • Celestron • Meade • Minolta

Olympus • Orion • Pentax • TeleVue®

Kendrick • Rigel • Star Bound • Vixen

We Ship Almost Anywhere!

www.camerabug.com

Fax: (404) 873-3925

Orders Only: (800) 545-8509

(404) 873-4513

1799 Briarcliff Rd. • Atlanta, GA 30306

Binocular Narrow-Band Nebula Filters $140 + $5 S&H

Sizes to fit many makes and models

Now for roll-down eyecups incl. Canon IS

SkyPointer™ Top Quality ***green*** laser pointer $185+$5 S&H

+ ***SkyFinder***™ Bracket

Telrad® bracket $40

Other Brackets Available

+ ***Remote Kit*** $30

= ***Finder Heaven***

plain bracket $35

(SkyPointer™ not included with brackets)

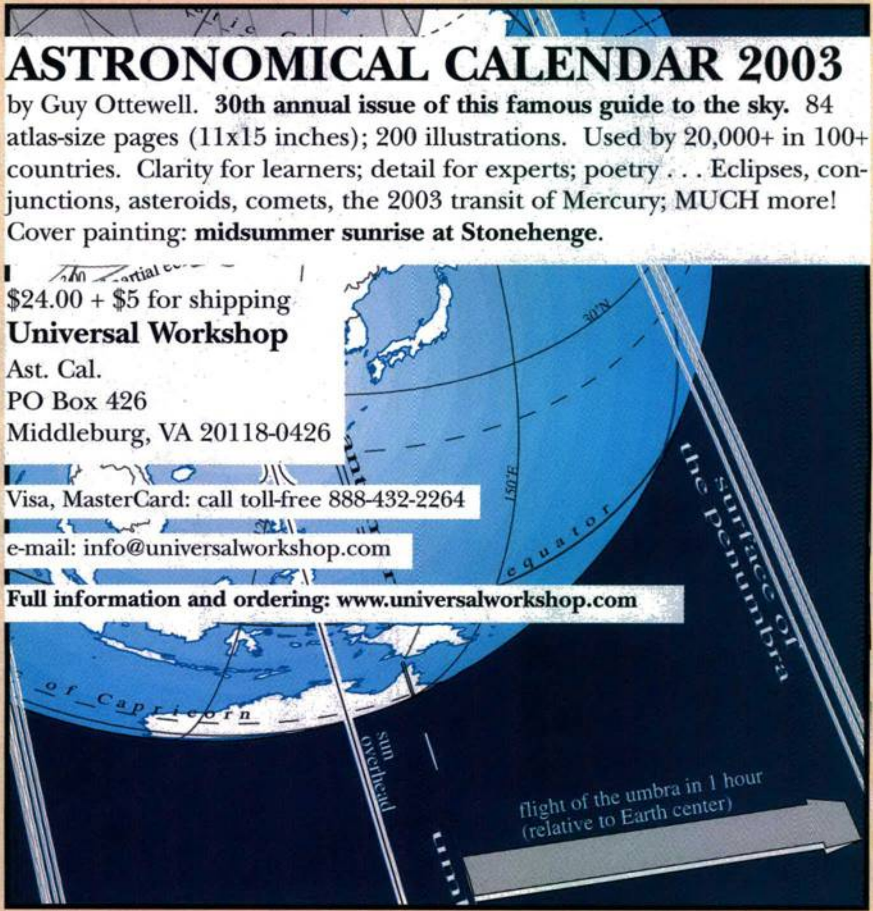
And...the finest Laser Collimators in **this** Solar System

Howie Glatter 3850 Sedgwick Ave. Bronx, N.Y. 10463

Tel/Fax (718) 796 3203

www.skypointer.net www.collimator.com

e-mail: howieglatter@mindspring.com



ASTRONOMICAL CALENDAR 2003

by Guy Ottewell. **30th annual issue of this famous guide to the sky.** 84 atlas-size pages (11x15 inches); 200 illustrations. Used by 20,000+ in 100+ countries. Clarity for learners; detail for experts; poetry . . . Eclipses, conjunctions, asteroids, comets, the 2003 transit of Mercury; MUCH more! Cover painting: **midsummer sunrise at Stonehenge.**

$24.00 + $5 for shipping

Universal Workshop

Ast. Cal.

PO Box 426

Middleburg, VA 20118-0426

Visa, MasterCard: call toll-free 888-432-2264

e-mail: info@universalworkshop.com

Full information and ordering: www.universalworkshop.com

partial
30°N
150°E
equator
of Capricorn
sun overhead
the surface of the penumbra
flight of the umbra in 1 hour (relative to Earth center)

Astronomy's

Marketplace

Patent Pending

The Spectrum Filter Wheel

The Ultimate Lunar/ Planetary Filter with 12 Colors and Barlow

scopemerchant.com

$139.95 ***805-381-1885***

Dealer Inquires Welcome

DEEPSKYBINOVIEWER.COM

LOW POWER BINOCULAR VIEWER

STARTING AT $599

26MM PRISM SYSTEM

WORKS IN ANY DOBSONIAN, SCT OR REFRACTOR!

Info: 410-208-6014 • Orders: 866-340-4578

DENKMEIER OPTICAL CO.

Analytical Scientific

"The Source For All Your Astronomy Needs"

Visit our showroom and see the largest selection of telescopes in Texas. Meade, Celestron, Tele Vue®, Telescopes, binoculars, microscopes, spotting scopes, accessories, books, charts, posters. Science, nature and educational items.

Analytical Scientific

11049 Bandera Rd. • San Antonio, TX 78250

(800) 701-STAR (7827) • Fax: (210) 520-3344

E-Mail: asltd@analyticalsci.com

http://www.analyticalsci.com

Explore the Heavens & Earth with us in Northern Arizona

- **Largest telescopes (up to 36") for your use in the best dark skies**
- **Days filled with guided geologic tours and more**
- **Expert instruction/ assistance**
- **Comfortable accommodations**
- **Ideal for novice and expert alike**

ASTRONOMICAL ADVENTURES

educational and recreational adventure vacations

2532 North Fourth Street Suite 200
Flagstaff, Arizona 86004
(602) 485-4367

www.AstronomicalAdventures.com

METEORITES

Museum-Quality collectors' specimens. Meteorite jewelry, books, unique gift items. Authenticity guaranteed.

Color Catalog
$3 USA, Canada and Mexico
$6 Foreign
Refundable with order.

The Universe Collection
P.O. Box 3726-A, New Haven, CT 06525-0726
203 393-3395 *fax* 203 393-2457

www.universecollection.com
VISA • MC • AMEX

'SIRIUS'

direct from **Australia**

Sizes 7'6" or 11'6" or 22'0" dia.

Solid Fibreglass, whisper quiet. Mechanised dome rotation and hatch openings available.

Visit www.siriusobservatories.com

e-mail info@siriusobservatories.com

SPACE ART

satisfaction guaranteed

PAINTINGS
PRINTS
POSTERS
SOFTWARE
BOOKS

We are the world's only space art gallery, with the largest selection of dazzling visions by the world's finest space artists.

Prompt Friendly Knowledgable

EXCLUSIVE gallery for paintings from astronaut-artist

ALAN BEAN

limited editions also

Moonwalker
autographed photos
authenticity guaranteed

Flags, patches and artifacts

FLOWN TO THE MOON

authenticated by the Apollo astronauts themselves

NOVASPACE galleries

Box 37197-M
Tucson, AZ 85740

catalogs $3 ($5 Int'l)

order online **www.novaspace.com**

Buy a Star ★ Name a Star

On the exclusive

MSAS Star Atlas

Soon to be placed in the newly-opened MSAS Astronomy Village

Receive a certificate of record and more.

Mtn. Skies Astronomical Society
Box 1169 - LkArwhd, CA. 92352

Free brochure.

Starting at only $25.00!

VISA/MC accepted

(909) 336-1699

www.mountain-skies.org

PEGASUS OPTICS - Mirrors

★Wavefront P-V <1/8 wave ★2" thick ★IAD Coating

Dia.	**FL**	**Price**	**Dia.**	**FL**	**Price**
18"	80"	$2300	22"	100"	$3800
20"	100"	$3000	25"	110"	$5800

"You'll see the difference" -John Hall

Web Site: PegasusOptics.Com E-mail: hallj@hilconet.com

TEL: (830) 563-2578

Your Passport to the Universe

DEEP SPACE HUNTER

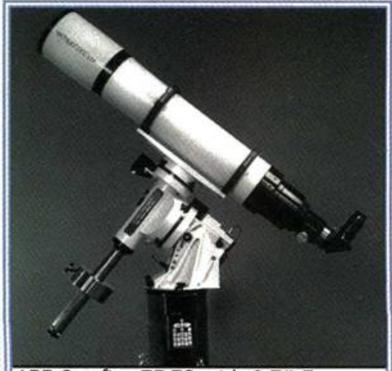
ForTheNightSky.com

Free Catalog: 1-800-394-3307

ASTRO-PHYSICS

High-quality instruments for discriminating observers and astrophotographers

Refractors- 105,130,155 mm dia.
Go-To German Equatorials
Visual and Photographic Accessories



155 Starfire EDFS with 2.7" Focuser, 900GTO German Equatorial Accessories

11250 Forest Hills Rd.
Rockford, IL 61115 USA

Ph: 815-282-1513, Fax: 815-282-9847

www.astro-physics.com

Optical Guidance Systems

Research Telescopes

World's #1 selling line of
Ritchey-Chretien Telescopes

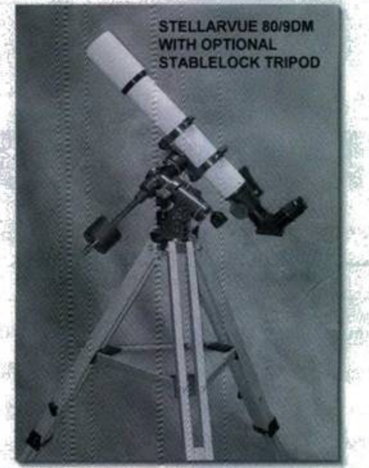
Custom-Made Ritchey-Chretien,
& Classical Cassegrain
Telescopes 10-40 inches.

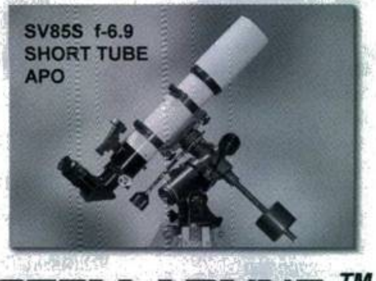
2450 Huntingdon Pike, Huntingdon Valley, PA 19006
Ph/Fax: (215) 947-5571

www.OpticalGuidanceSystems.com

STELLARVUE PRECISION REFRACTORS

BEST RATED
SHORT TUBE





STELLARVUE ™

WWW.STELLARVUE.COM
11808 KEMPER ROAD
AUBURN, CA 95603
Phone: (530) 823-7796
E-mail: mail@stellarvue.com

SCOPETRONIX PHONE/FAX
QUALITY ASTRONOMY PRODUCTS (239)945-6763

"The" place to look for new and unique accessories to get the most out of your scope!

ScopeTronix Digital Camera Solutions
We have the worlds largest selection of digital camera adapters

MaxView 40™ Eyepiece & Variable Projection Adapter for Digital Cameras

NEW PRODUCT!

The MaxView 40 is a unique fully multi-coated eyepiece and variable projection camera adapter all in one. For use as an eyepiece the eyeguard can be set to any height allowing for matching the eye relief to your eye for more comfortable viewing. In the left picture the threaded eyeguard has been removed revealing the integral "T" thread on the top of the eyepiece. The picture on the right shows how the outer sleeve can be adjusted up or down to the optimum setting to minimize vignetting for your particular camera. The MaxView 40™ is **specifically designed to help minimize vignetting in digital cameras with larger lenses** such as the Minolta D'image 5/7, Olympus 2xxx/3xxx/4xxx, Sony 505/707, Canon G1/G2 and many more. The MaxView 40™ is "T" threaded so you will need the proper step ring to mate it to your camera.

*Patent Pending

MaxView 40™ Eyepiece & Variable Projection Adapter..... **129.95**

Digi-T ™ T-Ring adapter for 1.25" eyepieces

Digi-T mates most digital camera models to the following eyepieces (must have rubber eyeguards):
Meade ETX, MA, Series 4000 Super Plossls, NexStar Plossls, Sirius Plossls, ScopeTronix Plossls, Series 300/400, and many MORE!

Digi-T provides the closest possible connection for the fullest possible picture!
Digi-T is secure, quick, and easy to use. Now you can even use 40mm eyepieces!
Digi-T won't raise the eyepiece like a projection adapter, no back focus problems!
Digi-T kits are available to fit most common digital cameras, video cameras too!

Mounting is easy! Simply pull off the rubber eyeguard, slip the Digi-T over the top of the eyepiece and tighten the set screws into the groove. The Digi-T will be flush with the top of your eyepiece. Now just thread on the step ring that mates it to your camera!

*Patent Pending

We now stock over 50 kits to fit all popular Digital Cameras, Call or visit our website for details!

Wide Angle Eyepiece & Digital Camera Adapter for Nikon Cameras

These 1-1/4" Wide Angle eyepieces feature an AFOV of over 66 degrees! For use as a camera adapter simply unscrew the eyeguard to reveal a 28mm thread. This will thread directly into the Nikon 800/900/990/995. Adapters in stock for use with other Nikons and 37mm (many Sony) cameras.

STWA14 14mm... **109.00** | **STWA18** 18mm... **99.00**

ScopeTronix Zoom Eyepiece & Digital Camera Adapter for Nikon Cameras

Our quality 1-1/4" zoom eyepiece features a 7-21mm zoom range. Attach the 28mm digital camera adapter and it threads onto any camera with a 28mm lens thread!

STZ721 7-21mm zoom EP.......................... **64.95**
STZ28 28mm digital camera adapter........ **34.95**

ScopeTronix EZ-PIX ™ Digital Camera Adapter

No lens thread on your digital camera? No problem! Our universal design fits any camera with a standard 1/4-20 threaded mounting hole. The padded eyepiece clamp slips over most Plössl eyepieces and barlow lens. The EZ-PIX is the original universal camera adapter, don't be fooled be cheap imitations that claim to be of an improved design. *The EZ-PIX is still the best design available!* Spacer included (shown at right)
Now includes two padded clamps to fit a wide variety of eyepieces!

EZPIX Universal Digital Camera Adapter.......... **49.95**

ScopeTronix Thread On Solar Filters for ETX Telescopes

Machined black aluminum filter cell securely threads onto ETX.
Quality Class A glass solar filter is manufactured by JMB.

SFETX60 fits ETX60 and ETX70.......... **64.95**
SFETX90 fits ETX 90............................ **84.95**
SFETX105 fits ETX 105........................ **94.95**
SFETX125 fits ETX 125........................ **99.95**

CrystalVue Optics Sharp Shooter 8x32mm Monocular and Digital Camera Lens

8x32mm monocular converts to a telephoto lens for digital cameras. Remove the rubber eyeguard to reveal a 37mm lens thread. Includes a 28mm to 37mm adapter ring.

CVOSS............. **149.00**

ScopeTronix ETX & NexStar Piggy Back Camera Mounts

PB70 ETX-60/70AT.... **42.95**
PBCM ETX-90EC/RA **49.95**
PB125 ETX-125EC... **64.95**
NPBACK NexStar 5 **59.95**
NPBACK8 NexStar 8 **35.00**

ScopeTronix ST Series Plössl Eyepieces

EP04 4mm ST Series Plössl **42.95**
EP06 6mm ST Series Plössl **42.95**
EP09 9mm ST Series Plössl **42.95**
EP15 15mm ST Series Plössl **42.95**
EP25 25mm ST Series Plössl **42.95**
EP30 30mm ST Series Plössl **52.95**
EP40 40mm ST Series Plössl **52.95**
EPSET Complete Set (7)........ **239.00**

ScopeTronix

Attention Beginners!
"Starry" says see
www.telescopes.org
for answers to your
questions!

Copyright 2002

WE ACCEPT:
DISCOVER
VISA
MasterCard
AMERICAN EXPRESS Cards

ScopeTronix Barlow Lenses

BAR2 2x.. **39.95**
BAR3 3x.. **42.95**

TeleVue Visionary

MEADE

NEW! Tripod Adapters & Accessory Holders for ETX!

See website for pricing

ScopeTronix Flexi-Focus™ for ETX scopes
Oversized knob and flexible shaft allow crisp, sharp focusing even when OTA is pointed straight up!

FLEX70 For ETX-60/70AT.. **34.95**
FLEX90 For ETX-90EC/RA **34.95**
FLEX125 For ETX-125EC.. **34.95**

Flexible shaft reduces vibrations. Achieve sharp focus fast!

ScopeTronix Eyepiece Bottles & Filter Cases

We now stock 6 different size eyepiece bottles to fit almost any size eyepiece!

STSBOX Small 1-1/4" filter size box.......... **1.95**
STLBOX Large reducer/corrector size box **2.95**

ScopeTronix Green Laser Pointer

5mw *continuous mode* laser beam is easily visible at night! 2 AAA batteries included. **$189**

ScopeTronix Astronomy Products • 1423 SE 10th Street Unit 1A • Cape Coral, Florida 33990

24 HOUR ONLINE SHOPPING & SECURE ORDERING
WWW.SCOPETRONIX.COM

Astronomy's
Marketplace

GREAT GIFT IDEAS!

Visit us on the web! **Astronomy** Call us toll free!

Mouse Pads,
CD Cases
& Buttons

Call for availability of your favorite space image!

www.QPads.com / 877-476-7547

Astronomy & Space Gizmos
Flying Toys & Rockets • Solar
Boats & Submarines • Globes
Nature & Science • Gyroscopes

explore4fun.com
800-595-9707

STARMASTER PORTABLE TELESCOPES

Hi Performance Dobs. Truss Mounted Scopes ranging in sizes from 11" up to 24"
2160 Birch Rd. • Arcadia, KS 66711
or Call: (620) 638-4743
9:00 am-9:00 pm **C.S.T 7 days a Week.**
www.starmastertelescopes.com

KITES!

Have fun anywhere the wind blows. Choose from hundreds of unusual kites in our FREE 80 page Catalog.

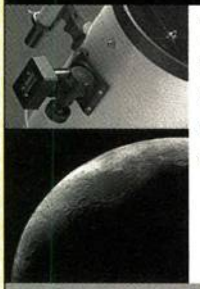
7-ft. Shark Kite

Into The Wind • (800) 541-0314
1408-A Pearl St., Boulder, CO 80302
www.intothewind.com

bigbinoculars.com

Astronomical binoculars (50-150mm) and accessories at down-to-earth prices.
Toll free- 866-244-2460 (BIG-BINO)
www.bigbinoculars.com
OBERWERK FUJINON

STELLAR ENDEAVORS, INC.
6701 Seybold Rd, Suite 209
Madison, Wisconsin 53719
(608) 271-6666



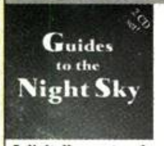
The AstroCam

The most affordable and easy to use color digital camera for amateur telescopes.

$189 plus S&H

Software Included!
Hardcases $24.95 (Deluxe $34.95)

Great Gifts!



5 digitally mastered audio tours

$29.95 plus S&H

The easiest way to learn the nighttime sky.
The perfect supplemental text for introductory astronomy courses!
"...truly fun..." - David H. Levy

www.stellarendeavors.com

BERGER BROS.

BLOW-OUT PRICES UP TO 40% OFF

- Celestar 8 with Computer
- Meade 8" F10 OTA 203
- Meade 102 Acromatic F9
- Meade 8" LX10 SC
- Meade 8" Starfinder EQ
- Meade 8" LX50
- Meade 10" Deluxe Dobsonian
- Meade 6" & 10" Starfinder EQ

Call us and get the best prices in the universe!

BERGER BROS.
209 Broadway, Rte. 110
Amityville, Long Island
800-262-4160 • www.berger-bros.com

Shop Online at
www.khanscope.com

Our 16th Year!

MEADE APD
Advanced products

RETAIL & MAILORDER

SKY MENTOR

Celestron, Meade, Tele Vue, Antares, Konus, Tal, Sky Mentor, Skywatcher, Binoculars, Spotting Scopes, Books, Software. All Major Brands on Display. We Welcome trade-ins, Buy, Used. Repairs & Service.

Khan Scope Centre
3243 Dufferin Street
Toronto, ON M6A 2T2

Voice: 416-783-4140
Fax: 416-783-7697
Toll Free: 1-800-580-7160

E-mail: Khan@globalserve.net

new mexico skies

"The Country's Finest Guest Observatory"
Tom Polakis, *Astronomy, June 2002*

☆ *Spectacular Skies*
DARK Steady Mag 7+ skies
Great Seeing - 7300' elevation

☆ *Great Equipment*
16"/14"/12" SCTs/CCD Cameras
7" Astro-Physics APO
30"/25"/15" BIG Dobs

☆ *Modern Accommodations*
Full size kitchens/3-2-1 bedrooms

Mike and Lynn Rice, Astronomers
www.nmskies.com
info@nmskies.com
Phone: 505-687-2429/Fax: 505-687-3710
P. O. Box 559, Cloudcroft NM 88317

Telescopes for everyone!

100% Product Certification
Competitive Prices
Best Customer Service
Largest Mid-Atlantic Dealer
Beginners Welcome!

NOW FEATURING
- New 8XL and 10XL Dobsonians
- New Meade Schmidt Newtonians and Refractors
- Sirius Filters
- Telescopes from $200–$200,000
- Introductory Classes

CELESTRON
MEADE
TAKAHASHI
SIRIUS FILTERS
PENTAX
LOMO
GTO
INTES
SKY INSTRUMENTS
THOUSAND OAKS
VERNONSCOPE
MANY USED ITEMS

Hands on Optics
866.726.7371 toll free/www.handsonoptics.com
26437 Ridge Road, Damascus, Maryland 20872

Astroshops.com

Your one-stop
shop for telescopes &
astronomy-related products

EUROPE'S PREMIER WEBSITE

http://www.scsastro.co.uk

SCS ASTRO

TRACKING for DOBS

* High power observing and group viewing
*Astro-imaging with NO field rotation
call write or e-mail for free brochure
EQUATORIAL PLATFORMS 530-274-9113
15736 McQuiston Lane Grass Valley CA 95945
tomosy@nccn.net www.equatorialplatforms.com

Astronomical Tours

Go Zero-G in 2003 !

Destination: Space!

Cosmonaut Training
Zero Gravity Flights
Neutral Buoyancy
Journey to the Edge of Space
Starting from $5400

2003 Antarctica Eclipse!
Aboard Icebreaker, Kapt. Khlebnikov

www.AstronomicalTours.net
• 660.747.9458 •
• 888.734.0311 Toll-Free •

TELESCOPE KITS, LENSES, ACHROMATS MIRRORS, MIRROR BLANKS, ALUMINUM COATINGS & ACCESSORIES
BUY DIRECT ★ DO IT YOURSELF

Stock & Custom mirrors and molded mirror blanks, diagonals, parts made from Pyrex, optical glasses, fused silica, quartz and other low expansion ceramic materials. Telescope accessories, do-it-yourself books.
Write, call, fax or e-mail for catalog

NEWPORT GLASS WORKS, LTD.
P.O. Box 127
Stanton, CA 90680
PH: (714) 484-8100
FAX: (714) 484-8181
E-mail: astronomy@newportglass.com
Web: http://www.newportglass.com

UNIVERSAL ASTRONOMICS

SIMPLY THE BEST TELESCOPE AND BINOCULAR MOUNTING SYSTEMS IN THE WORLD, CAN HOLD UP TO 50 LBS!

6 RIVER COURT
WEBSTER, MA 01570
PHONE/FAX 508-943-5105
www.universalastronomics.com
astronut@gis.net

UP TO 6 DEGREES OF MOTION

TAKE BACK THE NIGHT!
WITH THE NEW DARK SKY PORTABLE PANEL OBSERVATORY SYSTEM.

Dark Sky panels are lightweight, sturdy and simple to erect.

For Meade LX owners we also offer the ultimate aluminum eyepiece rack.

Visit our website at:
www.DarkSkyStuff.com
or call **877-DARKSKY**
for a free color brochure.

DARK SKY, INC.

THE "T&T ARTi MOUNT"

Buy the best spend less...

$205.00 (plus s+h)
Holds up to
100mm binoculars

This is our BEST BUY make it yours!!

T&T Binocular Mounts and Beyond LLC
18 Strong St. Extension • East Haven, CT 06512
(203) 469-2845 • E-mail: TELloyd@aol.com

www.benjaminsweb.com/TandT

SOLAR ECLIPSE
DEC 4, 2002
AFRICA and AUSTRALIA

On Dec. 4, 2002, a solar eclipse will be visible throughout Australia and Southern Africa. The only safe way to view solar eclipses is with Eclipsers safe solar glasses from American Paper Optics. **CE certified**, independently tested, and safe for direct solar viewing, **Eclipsers** are manufactured exclusively with *Solar Skreen®* lenses developed by astronomer Roger Tuthill. American Paper Optics has sold over 22,000,000 Eclipsers throughout the world over the last twelve years.

Eclipsers, colorfully printed with our commemorative Africa and Australia designs, are a spectacular retail sales item for science centers, museums, and planetariums. Custom-printed designs are also available for promotional use --call us for a quote! **Order Africa and Australia Eclipsers today!** Place your order three convenient ways: Call us at *(901)381-1515*, by fax at *(901)381-1517*, or email your order to *sales@3dglassesonline.com.*

AMERICAN PAPER OPTICS
3080 BARTLETT CORPORATE DRIVE • BARTLETT, TN 38133
901-381-1515 • FAX 901-381-1517 • www.3dglassesonline.com

Star Hill Inn

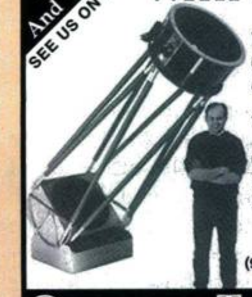
the premiere astronomy retreat in the country – since 1988

• Charming vacation guest houses with private baths, kitchens and porches, secluded on hundreds of acres of peaceful pines, under 6.5 + magnitude dark, spectacular skies • Twelve telescopes from 7" to 24", including 12" LX200 GPS and 16" LX 200, 14" Celestron Compustar and 24" R/C Cassegrain; CCD cameras: ST-7, ST-8 and STV Digital Video Camera • *Arriving in Spring 2003, 30" Obsession Telescope!* • Observation deck, Astronomical Library, Personal Guided Star Tours • Close to Santa Fe, Taos, ski resorts, and wildlife refuges. Birding, Hiking and Labyrinth. Open all year. 7200' elevation • Ideal for astronomy clubs, retreats, reunions, and holidays.
Gift Certificates Available.

Star Hill Inn, Sapello, NM 87745
505.425.5605 • www.starhillinn.com

The Original And The Best! SEE US ON THE WEB!

OBSESSED WITH THE BEST?



We are. Nothing else comes close to an Obsession.

Apertures from 15-30 inches.

Get Obsessed now. Brochure and a 2hr. video, just $2.

PO Box 804a
Lake Mills, WI 53551
(920) 648-2328 • Fax also

OBSESSION TELESCOPES™
www.obsessiontelescopes.com

ASTRO HAVEN
Non-Rotating Clamshell Domes

- 7' or 12' Diameter
- Low Maintenance
- Fast Erection
- Low Cost

Full 180° Viewing Radius

ASTRO HAVEN
12 ft
7 ft

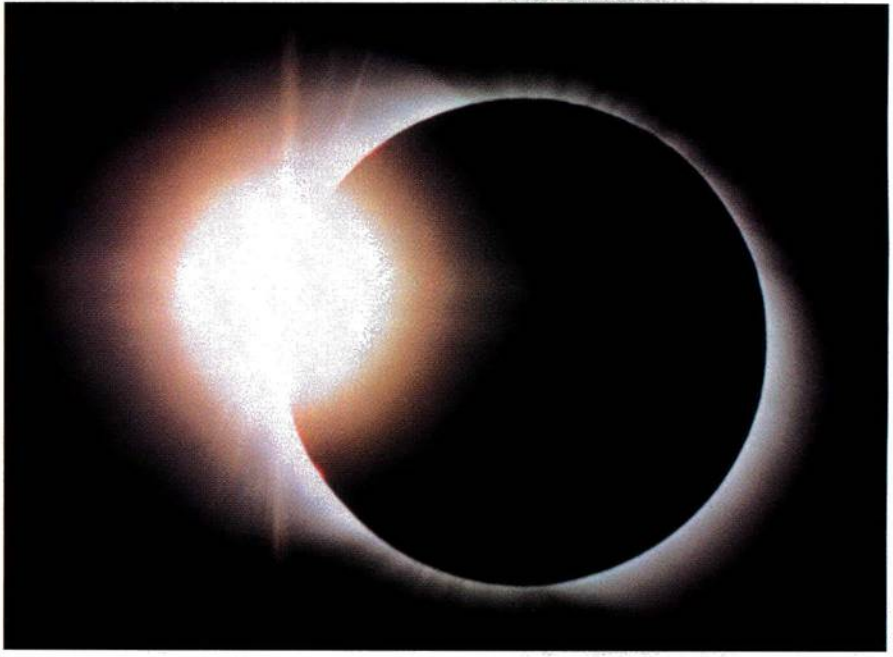
5650 Production Way, Langley,
British Columbia, Canada V3A 4N4
Phone **(604) 539-2208**
Fax **(604) 539-2209**
www.astrohaven.com *e-mail:* sales@astrohaven.com

For an astronomical experience of a lifetime, join *Astronomy* in Australia for the December 4 eclipse in Ceduna. Originating from Sydney, you will embark to exotic places on a full but relaxed itinerary. The tour includes observatories, star parties, planetaria, classes on the southern skies, the Swinburne Center for Astrophysics and Supercomputing, and sightseeing.

The trip includes star parties with expert guides who will show you the splendor of the southern skies. Guests will have the opportunity to add a side tour of the Great Barrier Reef and an additional weeklong visit to New Zealand.

Astronomy Senior Editor Rich Talcott will accompany the tour, guide your eclipse-viewing experience, and answer your questions. Rich will also be available on any clear night to show you the geography and significance of the rarely seen southern skies.

For more information on this trip or future *Astronomy* trips, e-mail Specialty Tours, markh@a1specialtytours.com, or visit its website, www.a1specialtytours.com/.


Ron Royer

Lucky observers in Australia during December's eclipse may glimpse the diamond ring effect.

YEAR-LONG EXHIBIT

Under One Sky

Adler Planetarium and Astronomy Museum, Chicago, Illinois. A year-long program celebrating the influence of astronomy in cultures around the world, spanning thousands of years. Under One Sky features the sky show *Skywatchers of Africa* and gallery show *Bringing the Heavens to Earth*. For more information, contact 312–922–STAR; website, www.adlerplanetarium.org.

NOVEMBER 14

Winter Wonders

State Museum of Pennsylvania, Harrisburg. In this star show, the Star of Bethlehem, Christmas traditions, and winter solstice celebrations from around the world are seen through the eyes of two children. For more information, visit the museum's website, www.statemuseumpa.org/exhibits/planetarium.html.

NOVEMBER 15–17

National Astronomy Meeting

Ouro Preto, Brazil. This fifth annual astronomical meeting is sponsored by Society of Astronomical Studies of Ouro Preto, Astronomical Observatory of the School of Minas, and the Federal University of Ouro Preto. For more information, contact Gilson Nunes, seaop@em.ufop.br; website, www.seaop.em.ufop.br.

NOVEMBER 18

Canary Islands Winter School of Astrophysics

Puerto de la Cruz, Tenerife, Canary Islands, Spain. The theme for the 16th annual island gathering is "Dark Matter and Dark Energy in the Universe." Organized by Instituto de Astrofisica de Canarias, this year's meeting features eight prestigious researchers working in several areas of the general topic of dark matter. For more information, contact Lourdes González or Nieves Villoslada at xivwinter@ll.iac.es; website, www.iac.es/winschool2002/1announce.html.

NOVEMBER 18

Skywatch

Dreyfuss Planetarium, Newark Museum, Newark, New Jersey. This free event will focus on Mars, Jupiter, and a preview of the Leonid shower. For more information, visit the Newark Museum's website, www.newarkmuseum.org/.

NOVEMBER 29–DECEMBER 1

Astronomical Society of Southern Africa Symposium

Aloe Ridge Hotel and Conference Centre, near Pretoria, South Africa. Hosted and organized by the Pretoria Centre of the ASSA, the symposium features local and international speakers, covering a wealth of astronomical subjects. The event will include presentations on the total solar eclipse of December, which will be visible from the northern border of South Africa. For more information, contact Joy, 27–12–667–4845; e-mail, joyness@worldonline.co.za.

DECEMBER 6

Comets

Priory Street Centre, York, England. Jonathan Shanklin of the British Antarctic Survey will lead a discussion on comets. For more information, e-mail, yas@talk21.com; website, www.yorkastro.freeserve.co.uk/.

DECEMBER 7–8

Star-B-Q

Leon Mow Dark Sky Site, Heathcote, Victoria, Australia. The 12th annual Star-B-Q is hosted by the Astronomical Society of Victoria. For more information, visit its website, www.asv.org.au/.

DECEMBER 14

Denver Astronomical Society Open House

Chamberlin Observatory, University of Denver. The Denver Astronomical Society's monthly open houses are an opportunity for the general public to learn more about astronomy. Members bring their telescopes to share with anyone and everyone interested in taking a look at the wonders of the universe. The theme for December's open house is "How to Buy a Telescope." For more information, visit the society's website, www.denverastro.org/.

DECEMBER 21

The Day of the Sun's Return, Winter Solstice

Montgomery College Planetarium, Takoma Park, Maryland. For more information, visit its website, www.mc.cc.md.us/Departments/planet/.

DECEMBER 28

Central Texas Star Party

Turner Research Station, Turnersville, Texas. In case of poor conditions, the alternate date is January 4. For more information, visit its website, www.centexastronomy.org/.

JANUARY 5–9

Annual Meeting of the American Astronomical Society

Washington State Convention and Trade Center, Seattle, Washington. Featuring lectures, discussions, and special events. Early registration deadline is November 27. For more information, visit the AAS website, www.aas.org/.

JANUARY 11–15

126th American Association of Physics Teachers National Meeting

Renaissance Hotel, Austin Texas. The theme for this AAPT gathering is "Physics in Space." The AAPT will meet concurrently with the National Society of Hispanic Physicists. For more information, visit its website, www.aapt.org/. ■

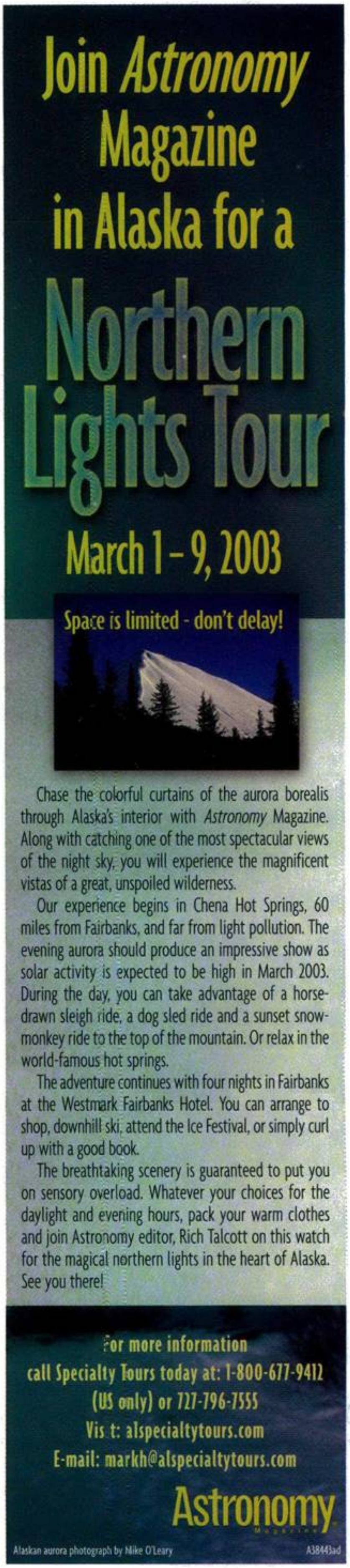
CONTACT

Please submit club announcements four months in advance to Looking Ahead, *Astronomy*, P.O. Box 1612, Waukesha, WI 53187, or jmcgovern@astronomy.com. Add your events to our online calendar at http://www.astronomy.com.

AD INDEX

We believe that our readers are as important as our advertisers; therefore, we try to handle all reader's complaints promptly and carefully. If, within 30 days you do not receive your merchandise or an adequate reply from an advertiser, please write to us. In your letter describe exactly what you ordered and the amount of money you sent. We will forward your complaint to the advertiser for action. If no action is obtained, we will refuse to accept further advertising from him. Address complaints to: ASTRONOMY Magazine, 21027 Crossroads Circle, P. O. Box 1612, Waukesha, WI 53187.

Adorama	20,21
American Paper Optics Inc	105
Analytical Scientific	102
Astro Auction.com	101
Astro Haven	105
Astro-Physics	102
Astrographics Publishing	55
Astronomical Adventures	102
Astronomics	18
Astronomy.com	95
Astronomyquest.com	25
Astronomy Binders	99
Astronomy Calendar	98
Astronomy Magazine	27,99
Astrotec	100
Atomic Time	54
Berger Brothers Camera/Video	104
Beta Electronics	101
Bethany Sciences	102
Binoculars.com	101
Bob's Knobs	100
Camcor, Inc	47
Camera Bug	101
Canon USA Inc	31
Celestron International	48
Dark Sky Inc	105
Davis Instruments	99
Denkmeier Optical	102
Eclipse 2002 Tour to Australia	
Equatorial Platforms	105
Explore	104
Firefly Books Ltd	29
Focus Camera	14
Glatter, Howard	101
Hands on Optics	104
Hardin Optical Co	102
Hawaiian Astronomy Tour	108
Ic Stars Astronomy	105
In2space.com	100
Infinity Telescopes	20
Into the Wind/The Kite Source	104
JMB Inc	54
Jim's Mobile Industries	89
Kendrick Astro Instruments	25
Khan Scope Centre	104
Konus Italia Group	23
Learning Technologies Inc	100
Lumicon, Inc	100
Marketplace Pages	100,101,102,103,104,105
Meade Instruments Corp	2,3,7,8,9,10,11,114
Mountain Skies Astronomical Society	102
National Academy Press	73
New Mexico Skies	104
Newport Glass Works	105
Nisur Systems	101
Northern Lights Tour 2003	107
Novaspace	102
Observatory Inc., The	100
Obsession Telescopes	105
Oceanside Photo & Telescope	17
Optical Guidance Systems	103
Orion Telescopes & Binoculars	40,113
Owl Services	100
Pacific Coast Graphics	104
Pegasus Optics	102
Questar Corporation	25
Rainbow Symphony	101
RITI	20
Rivers Camera Shop	47
SAC Imaging Systems	100
SCS Astro	100
Santa Barbara Instrument Group	33
Scientifics	99
Scope City	54
Scope Merchant	102
Scopetronix	103
Shutan Camera & Video	47
Sirius Observatories	102
Sky Watchers Inn	100
Smithsonian Institution Press	31
Software Bisque	79
Star Hill Inn	105
Starizona	95
Starmaster Portable Telescope	104
Stellar Endeavors	104
Stellar Technologies Intn'l	100
Stellarvue	103
T & T Binocular Mounts & Beyond LLC	105
Technical Innovations	25
The Telescope Store	20
Tinelli, Michael	101
Travel Quest	25
Universal Astronomics	105
Universal Workshop	101
Website Directory	98
Woodland Hills Photo Images	73
www.bigbinoculars.com	104



Join *Astronomy* Magazine in Alaska for a Northern Lights Tour

March 1–9, 2003

Space is limited - don't delay!

Chase the colorful curtains of the aurora borealis through Alaska's interior with *Astronomy* Magazine. Along with catching one of the most spectacular views of the night sky, you will experience the magnificent vistas of a great, unspoiled wilderness.

Our experience begins in Chena Hot Springs, 60 miles from Fairbanks, and far from light pollution. The evening aurora should produce an impressive show as solar activity is expected to be high in March 2003. During the day, you can take advantage of a horse-drawn sleigh ride, a dog sled ride and a sunset snow-monkey ride to the top of the mountain. Or relax in the world-famous hot springs.

The adventure continues with four nights in Fairbanks at the Westmark Fairbanks Hotel. You can arrange to shop, downhill ski, attend the Ice Festival, or simply curl up with a good book.

The breathtaking scenery is guaranteed to put you on sensory overload. Whatever your choices for the daylight and evening hours, pack your warm clothes and join Astronomy editor, Rich Talcott on this watch for the magical northern lights in the heart of Alaska. See you there!

For more information
call Specialty Tours today at: 1-800-677-9412
(US only) or 727-796-7555
Visit: alspecialtytours.com
E-mail: markh@alspecialtytours.com

Astronomy Magazine

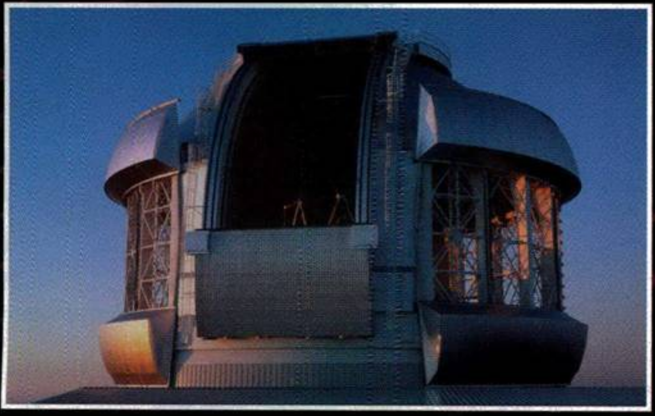
Alaskan aurora photograph by Mike O'Leary

A38443ad

Join the editors of *Astronomy* magazine on an astronomy tour of HAWAII!

Honolulu – Waikiki Beach, Hilo and Mauna Kea • April 26 – May 4, 2003

- Three nights in Honolulu, including Waikiki Beach
- Inside tour of some of the biggest telescopes in the world
- See the Keck, Gemini, and Subaru telescopes
- Enjoy two private visits to the summit of Mauna Kea
- Observe from 9,300 feet in the darkest skies on Earth
- We'll provide the telescopes (or bring your own), including a 16-inch SCT, 14-inch SCT, 11-inch SCT, and 8-inch SCT
- Five nights in Hilo, Hawaii
- Celebrate special Astronomy Day festivities
- Visit Hawaiian Volcanoes Observatory and see an erupting volcano
- Enjoy a full day tour of Honolulu, including the *USS Arizona*
- Visit Hilo's new Science and Tech Park
- Fully escorted
- The best rooms at the best resorts!



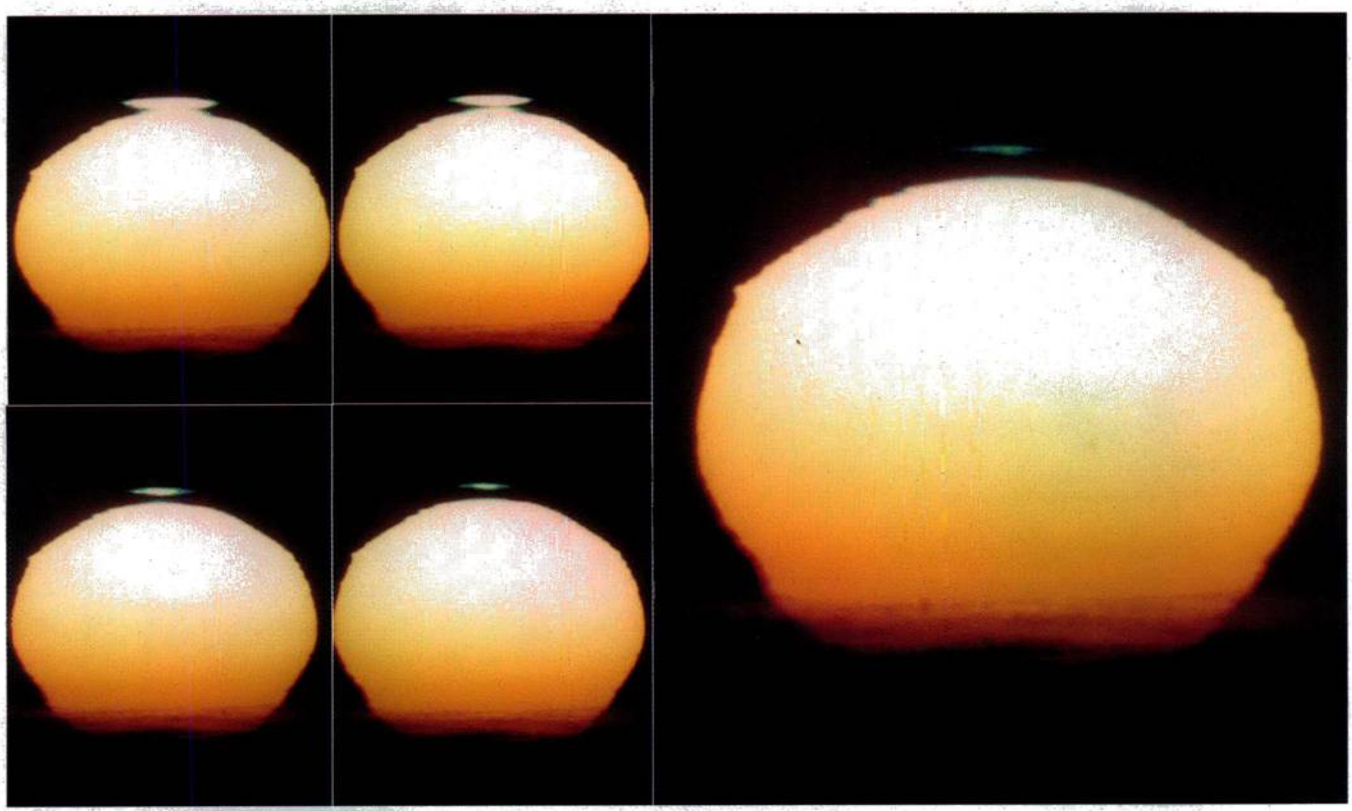
FOR MORE INFORMATION, CONTACT:

Mayhugh Travel • 701 Perdew Ave. • Ridgecrest, CA 93555
(888) 412–5317 • Outside the U.S., call 1–760–446–0050
For details, visit http://astronomyvacations.com • (CST# 2049910–40)

A30570A01

HOT SHOTS

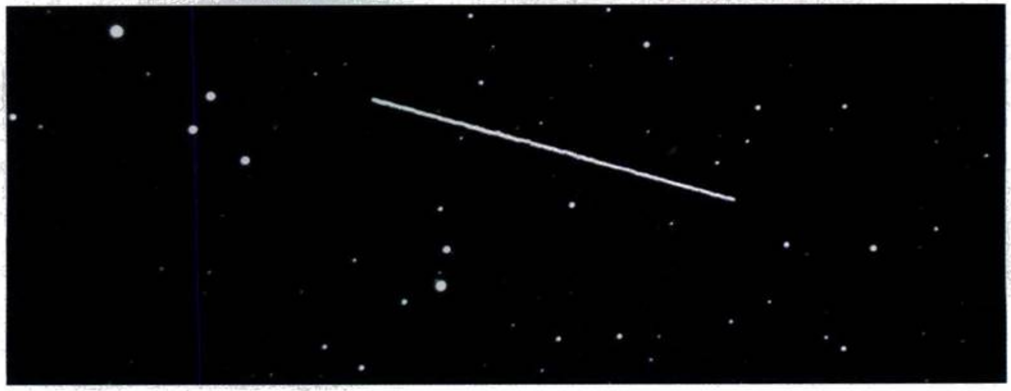
A collection of your images and observations



▲Green Flash Sequence

PETE WARD

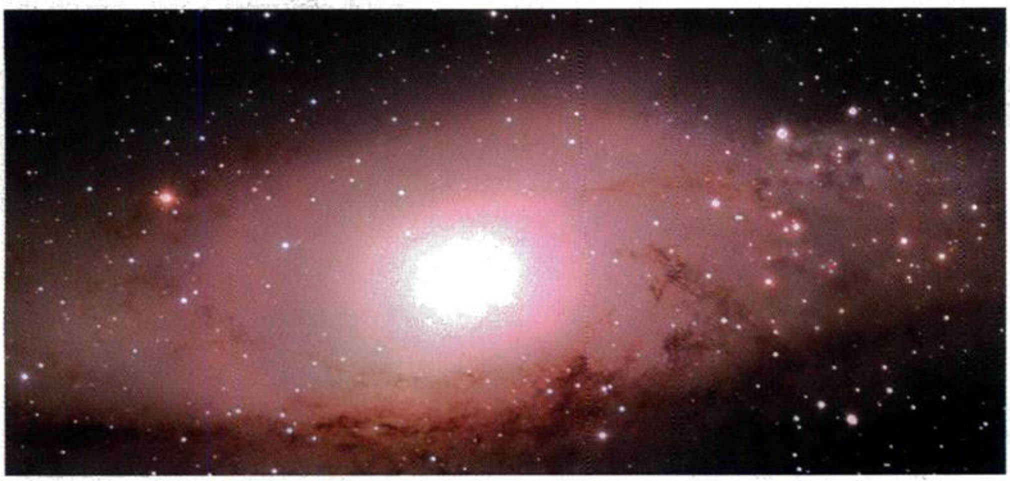
(500mm lens at f/8, Fuji Superia 400 film, taken March 20, 2002, in La Jolla, California)



◀Asteroid NY40

JACK NEWTON

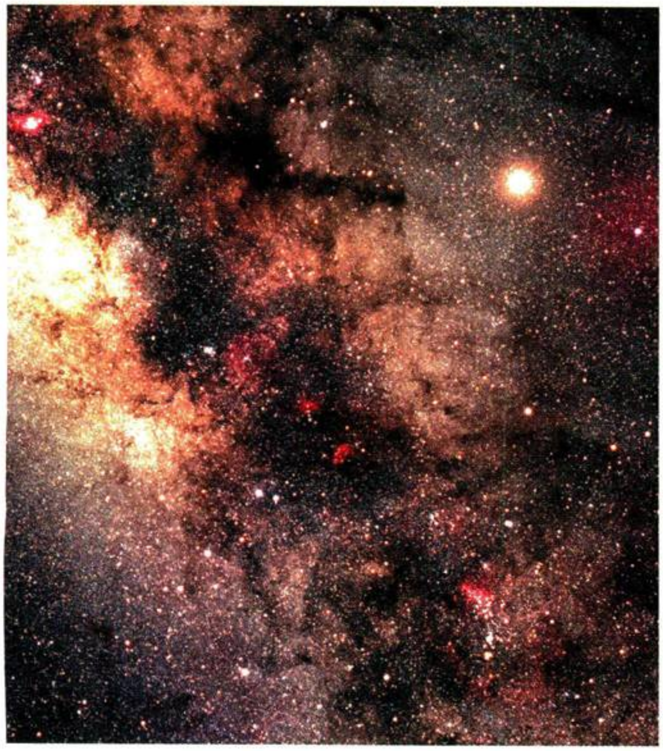
(16-inch SCT at f/10, Finger Lakes Dream Machine CCD camera, taken August 18, 2002)



◀Core Region of M31

ROBERT GENDLER

(12.5-inch Ritchey-Chrétien scope at f/7, IMG 1024 CCD camera, composite exposure)



▲Solar Eclipse

FABRIZIO MELANDRI

(400mm lens at f/7, Fuji Velvia 50 film, taken June 10, 2002, in Tuxpan, Mexico)

◀◀Scorpius and Sagittarius

HERMANN VON EIFF

(50mm lens at f/5.6, composite of two 45-minute exposures, taken in July 2001 in Namibia)

◀The Omega Nebula (M17) in Sagittarius

DAVID HANON

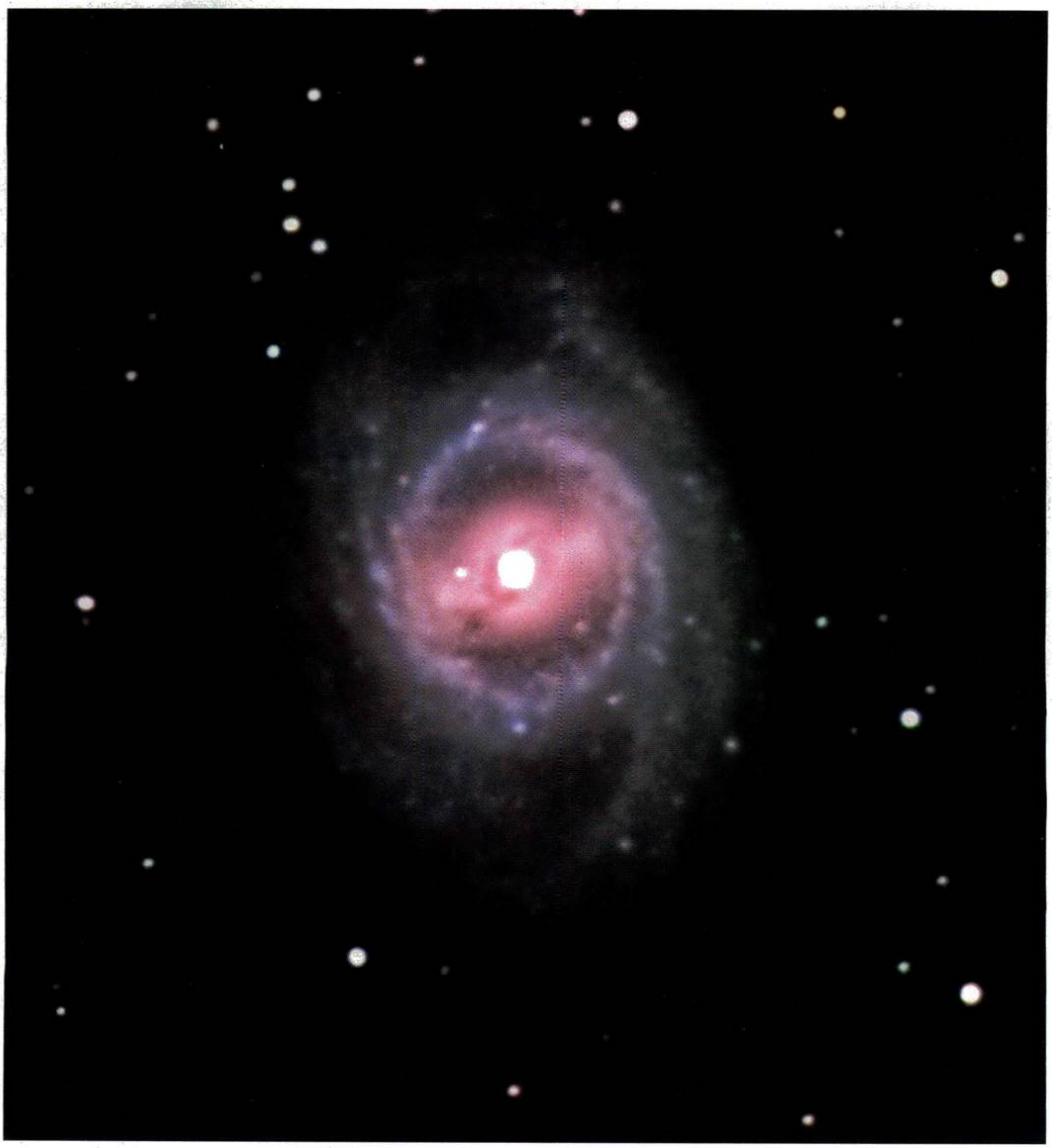
(7-inch refractor at f/7, SBIG ST-10E CCD camera, composite of three 30-minute exposures)

▶Starfield over Avenue Baobab, Madagascar

FABRIZIO MELANDRI

(28mm lens at f/2.5, Kodak Ektachrome 1600 film, 2-minute exposure)

This month's best astrophoto



Spiral Galaxy M95 in Leo

RALPH SARGENT

(12-inch SCT at f/6.3, SBIG ST-7E CCD camera, composite exposure)

This superb photo reveals the delicate detail of the barred spiral galaxy M95, including its nucleus and arm structure.

New! SKYVIEW PRO™ TELESCOPES

Great Optics and an All-New Mount

SKYVIEW PRO 100 EQ
$499

SKYVIEW PRO 120 EQ
$599

SKYVIEW PRO 6 EQ
$489

SKYVIEW PRO 8 EQ
$579

SPECIAL OFFER!
FREE TrueTrack Single-Axis Electronic Drive
A $69.95 Value!
Or...
Save $70 on TrueTrack Dual-Axis Drive
Reg. ~~$119~~ $49

FREE Color CATALOG!
Call toll-free
(800) 447-1001
or request it online.

ORION
TELESCOPES & BINOCULARS

Everything for the Amateur Astronomer — Delivered Direct

telescope.com

The Meade 30th anniversary sale

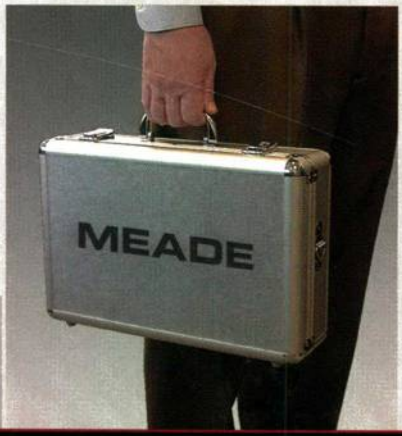
Buy a Meade telescope and receive a $650 Meade Super Plössl eyepiece set for only $99!

SUPER PLÖSSL 6.4mm
PER PLÖSSL 9.7mm
PLÖSSL 12.4mm
PLÖSSL 15mm
PER PLÖSSL 20mm
DE SUPER PLÖSSL 26mm
DE SUPER PLÖSSL 32mm
SUPER PLÖSSL 40mm

Now for a limited time, to celebrate Meade Instruments' 30 years in telescopes, you can buy a Meade telescope* and receive a full set of Meade premium-grade Super Plössl eyepieces for only $99 additional. Never before have we made such an incredible offer available for such a wide range of our most popular telescope models.

Choose from more than a dozen qualifying Meade telescopes *(see listing at right)*, mail us your check for $99, and we'll ship your Super Plössl eyepiece set directly to you. And we'll pack your eyepieces in the Meade #771 foam-lined aluminum carrying case, itself a $49.95 value if purchased separately. For complete details see the HOW TO ORDER box at right.

Designed and manufactured to exacting standards, Meade Series 4000 Super Plössl eyepieces deliver wide 52° apparent fields (44° for the SP40mm) with all of the resolution, edge-of-field sharpness, and color correction demanded in the most advanced visual applications. All eyepieces are brand-new and factory fresh; each is multi-coated, includes a soft rubber eyeguard, and is individually packed in a thread-on poly container. There are no finer general-purpose eyepieces available.



The Meade #771 aluminum carrying case, included with this special offer, provides rugged, secure storage for your Super Plössl eyepiece set.

This special offer includes the following eyepieces:

SP6.4mm	$79.95
SP9.7mm	79.95
SP12.4mm	79.95
SP15mm	79.95
SP20mm	79.95
SP26mm	(standard equipment)**
SP32mm	99.95
SP40mm	99.95
#771 Aluminum Carrying Case	49.95
Total price if purchased separately:	**$649.60**

***Telescopes qualifying for this special offer include:**

ETX models: ETX-90EC, ETX-105EC, ETX-125EC
LXD55 models: 6" SN-6, 8" SN-8, 10" SN-10, 8" SC-8, 5" AR-5, 6" AR-6, 6" SN-6EC, 8" SN-8EC, 5" AR-5EC
LX90, LX200GPS models: 8" LX90; 7", 8", 10", 12", 14", 16" LX200GPS

HOW TO ORDER

1. Buy any qualifying Meade telescope from an authorized Meade dealer in the U.S.A. between August 15, 2002 and November 30, 2002.

2. Fax or mail a copy of your dealer's invoice, plus the completed warranty card packed with the telescope, along with your payment of $99 to Meade Instruments/Attn: Customer Service, and request the "$99 Eyepiece Offer." *Requests must include your complete shipping address and phone number.*

3. We will ship your eyepiece package to you within 30 days of our receipt of your request. Meade Instruments will pay for all shipping and insurance charges; safe arrival is guaranteed.

Other terms and conditions: Payment may be made by personal check (payable to Meade Instruments) or credit card (VISA or MasterCard). **California residents must add $7.67 sales tax, for a total payment of $106.67.** Requests for this special offer must be postmarked not later than December 31, 2002. This special offer is valid only for new Meade telescopes ordered and received within the U.S.A. (Outside the U.S.A. contact your Meade international distributor.) There is no limit to the quantity of telescopes each person may order: each qualifying telescope is eligible to receive the special eyepiece package. Prices shown are suggested U.S. mail-order retail prices. **The SP26mm eyepiece (shown in photos above) is packed with each qualifying telescope as standard equipment.

ADVANCED PRODUCTS DIVISION
Meade Instruments Corporation
The largest-selling telescopes in the world. ■ A NASDAQ® company.
6001 Oak Canyon, Irvine, California 92618 ■ (949) 451-1450
1-800-62-MEADE ■ FAX: (949) 451-1460 ■ *www.meade.com*